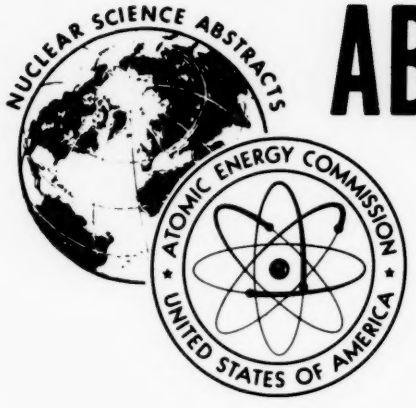
NUCLEAR SCIENCE ABSTRACTS



Volume 25 Number 19

Abstracts 44311-46421

October 15, 1971

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Volume 25, Number 19, October 15, 1971

NUCLEAR SCIENCE ABSTRACTS

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separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

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Volume 25, Number 19 October 15, 1971

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

44311 (ANL-Trans-891) CHEMICAL ANALYSIS. (Commissariat a l'Energie Atomique, Fonteany-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 1, pp 5-90 of report CEA-N-1419. 83p. Dep. NTIS.

An abstract of this section, prepared from the original language, appeared as a part of NSA 25: 31788. (J.G.B.)

44312 (NYO-844-84) NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH. Progress Report, 1970-1971. Kohman, Truman P.; Karol, Paul J. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). 31 May 1971. Contract AT(30-1)-844. 69p. Dep. NTIS.

Separate abstracts were prepared for the eight papers presented. (W.H.K.)

For abstracts of individual papers see: 44316, 44338, 44415, 44440, 44441, 44584, 44663, and 45255.

44313 CHEMICAL ANALYSIS IN EXTRACTIVE METALLURGY. Young, R. S. London; Gifffin (1971). 427p. £7.

Laboratory work in mining and mineral processing is covered. Modern methods, both instrumental and "wet," for the analysis of 45 elements, including the following of specific nuclear interest: Be, B, C, Li, Mg, Mo, Nb, Ta, Th, W, U, V, and Zr, are included. (UK)

Chemical and Spectral Procedures

Refer also to abstracts 44378 and 44555.

44314 (AEC-tr-7239) SEMIQUANTITATIVE CHEMICAL ANALYSES BY MASS SPECTROMETRY WITH IONIZATION BY PHOTON BOMBARDMENT WITH A RUBY LASER. Eloy, J. F. Translated by P. J. P. Chastagner (Du Pont de Nemours (E. I.) and Co., Aiken, S. C.), from J. Mass Spectrom. Ion Phys.; 6: 101-15(1971). 10p. Dep. NTIS.

A single-focusing mass spectrograph source permits a record to be made, on a photoplate, of low-energy ions obtained directly from a sample on which the focused beam of a ruby laser impinges. The small size of the crater (diameter <200 μ; depth: 0.6 to 0.8 μ) allows the application of this apparatus to the microanalysis of surfaces, such as UO_2 surfaces, and particularly to the determination of inclusions. Progress in the use of the laser and apparatus techniques permitted some applications; analysis of miscellaneous samples, metals, or insulators. An application is the analysis of small mineral inclusions in ores. The threshold of detection is about 0.5 to 0.1% with one laser shot. The accuracy of atomic ratio determination is better than ±20%. (auth)

44315 (EURFNR-852) TRACE DETERMINATION IN NUCLEAR FUELS BY EMISSION SPECTROSCOPY. Mainka, E.; Mueller, H. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translation of report KFK-1261. 37p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

An abstract of this report, prepared from the original language, appeared as NSA 25: 10432. (auth)

44316 (NYO-844-84, pp 26-43) ISOTOPIC COMPOSITION OF LEAD AND THALLIUM IN NATURAL MATERIALS. Huey, James M. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

The ratio of lead to thallium and the isotopic abundances of each in natural materials are discussed. The chemical procedure for isolation of lead and thallium is described. This is followed by mass spectrometry. Results for lunar fines and meteorites are presented. (M.C.G.)

44317 (TID-25747) DEVELOPMENT AND APPLICATION OF COULOTRIMETRY: CONTROLLED-CURRENT COULOMETRIC TITRIMETRY. McCracken, Jack Edwin (Missouri Univ., Columbia). Jun 1971. 168p. Dep. NTIS.

Thesis.

The development of the controlled-current coulometric titrator, Coulotrator, and its use to solve several different types of analytical problems were studied. The analytical technique and procedures that should be used in adjusting and calibrating the Coulotrator are discussed. Methods for determination of iron, iron-uranium, and iron-uranium-vanadium systems are outlined. Coulometric determination of chloride, bromide, and iodide was also carried out. Methods were also developed for determination of curium and neodymium. (M.C.G.)

44318 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN MILD AND LOW ALLOY STEELS. Mather, D. M.; Millar, F.; Pollock, A. F. (British Steel Corp., Motherwell, Eng.). Analyst: 96: No. 1143, 393-7(Jun 1971).

The colored complex that is formed between Zr, Eriochrome cyanine R, and polycyclic ketoamine was studied and applied in the spectrophotometric determination of Zr in mild steel at concentrations ranging from 0 to 0.1% with an estimated precision of ±0.003% Zr. By preliminary separation of Zr with phenylarsonic acid, other elements that form complexes with Eriochrome cyanine R and polycyclic ketoamine are partially or totally removed. Provision is also made for the removal of elements that coprecipitate or adsorb Zr in acidic solution, thus extending the method to include more complex steels. Ti in amounts greater than 0.02% interferes. The main advantages of the method are that residual Fe can be effectively masked without any loss in stability of the complex and that the molar absorptivity of the analytical complex is high. (auth) (UK)

44319 COMPARISON OF SPECTROPHOTOMETRIC REAGENTS FOR CERIUM. Fedorova, N. D.; Fokina, L. S. Tr. Vses. Nauch.-Issled. Inst. Stand. Obraztsov Spektr. Etalonov: 5: 49-58(1969). (In Russian).

Of 14 reagents studied, the leuco-base of Malachite Green is recommended for determining Ce(IV), Xylenol Orange for determining Ce(III), and Arsenazo III for determining Ce in either valency state. (Referativnyi Zh.)

44320 PHOTOMETRIC DETERMINATION OF SCANDIUM WITH 1,5-DIANTIPYRINYL-3-CYANOFORMAZAN. Budesinsky, B. W.; Svec, J. (Univ. of Waterloo, Ont.). Microchem. J.; 16: No. 2, 253-8(Jun 1971).

The determination of scandium using 1,5-diantipyrinyl-3-cyanoformazan is the most sensitive photometric method for that element. The effective molar absorptivity for scandium is 60,000 cm^2/mmole for pH 4.5 ± 0.3 and the wavelength of 552 nm. Inter-

fering monovalent and divalent ions are masked by potassium cyanide or sodium thiosulfate. Trivalent and tetravalent ions must usually be removed by a preliminary separation based on ion exchange or extraction. (auth)

44321 EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF SEXAVALENT URANIUM WITH ARSENAZO III IN AQUEOUS-ORGANIC MEDIA. Perez-Bustamante, J. A.; Palomares Delgado, F. (Ciudad Univ., Madrid). Analyst; 96: No. 1143, 407-22(Jun 1971).

The determination of U(VI) was carried out by extraction–spectrophotometric methods based on the use of tributyl phosphate dissolved in isobutyl methyl ketone and trioctylphosphine oxide in benzene. Arsenazo III is used as the metallochromic reagent in a medium buffered with monochloroacetic acid–sodium monochloroacetate. The effect of many cations and anions on the procedures was investigated, including the elimination of the important interference caused by Pu. The applicability of the methods evolved was demonstrated by the comparative analysis of a series of international secondary U ore standards and some other low-content U ores that were analysed by independent chemical methods. The trioctylphosphine oxide–benzene–Arsenazo III procedure, which was shown to be greatly superior to the other methods, permits the direct determination of U(VI) in the presence of Pu when the U-to-Pu ratio is greater than 0.2%. The method was also found suitable for the determination of U in monazitic sands, rare earth concentrates, zirconium-bearing materials, and phosphoric acid solutions of the type used for the leaching of low-grade U ores. (auth) (UK)

44322 DIFFERENTIATION OF HALIDE BY DRY METHOD. Tsubaki, Isamu; Nakanishi, Tsutomu (Osaka Electro-Communication Univ.). Jap. Anal.; 20: No. 5, 549-51(May 1971). (In Japanese).

Chloride, bromide, and iodide were oxidized by fusion with vanadium(V) oxide to liberate gases of halogens identifiable by their colors. Bromide and iodide were oxidized to halogens by fusion with sodium hydrogen sulfate, and only iodide was oxidized to iodine by fusion with boric acid. By combining these three tests, a halide was identified solely by dry method. (auth)

44323 ISOTOPE ANALYSIS OF SMALL QUANTITIES OF HYDROGEN. Nemets, V. M.; Shabdukarimov, B. A. Vestn. Leningrad. Univ., No. 22, Fiz. Khim.; No. 4, 155-7(Nov 1970). (In Russian).

In the spectral examination of the isotopic composition of small quantities (10^{-2} cm^3 under normal conditions) of hydrogen the processes of sorption, desorption, and isotope exchange on the walls of the discharge tube influence the results. The distortions caused by these processes can be calculated by means of a graphical method based on the construction of a curve of time change value I_H/I_D in the process of discharge. Such a method of calculation of distortions makes possible an isotope analysis of the mixture with the quantities not larger than 10^{-2} cm^3 under normal conditions. (auth)

44324 DETERMINATION OF URANIUM(IV), URANIUM(VI), AND TOTAL URANIUM IN PHOSPHORIC ACID PROCESS SOLUTIONS BY TRI-n-OCTYLAMINE EXTRACTION AND POLAROGRAPHY. Hodara, Isaac; Balouka, Isaac (Israel Atomic Energy Commission, Beer-Sheva). Anal. Chem.; 43: No. 10, 1213-18(Aug 1971).

Uranium(VI) is separated from U(IV) by extraction with tri-n-octylamine (TOA) in xylene from a mixture of phosphoric and hydrochloric acids. Uranium(VI) is backextracted from the TOA–xylene solution with dilute hydrochloric acid and is determined by polarography in 4N HCl medium. For total uranium determination, U(IV) is oxidized with ferric chloride prior to extraction. Impurities present in the phosphate rock, including vanadium, molybdenum, and chromium, do not interfere. The method is simple, rapid, and accurate. Six to eight determinations can be carried out per day by a trained technician. The relative standard deviation is 2% at the 95% confidence level for samples containing 0.05 to 0.2 mg uranium per milliliter. (auth)

44325 COMPOSITIONAL DETERMINATION OF SPUTTERED TANTALUM–ALUMINUM THIN FILMS. Nohe, James D.; Green, David A. (Western Electric Co., Inc., Princeton, N. J.). Appl. Spectrosc.; 25: No. 4, 489-93(Jul-Aug 1971).

Tantalum–aluminum thin film composition was determined destructively by atomic absorption and nondestructively by x-ray fluorescence spectroscopy. Samples representing several compositions (20 to 80 at. % aluminum) and thicknesses (500 to 6000 Å) were sputtered on glass, graphite, and platinum substrates. The films were dissolved from the platinum substrates for determination of aluminum by atomic absorption. The weights of tantalum per unit area obtained by difference using this destructive technique were applied to the same samples on glass substrates for correlation with nondestructive x-ray fluorescence measurements. A linear curve, which is free from enhancement and absorption effects, was obtained for tantalum. This curve relates the nondestructive fluorescence intensities to film weights (μg/cm^2) of tantalum. The composition of the film is determined nondestructively by utilizing this curve and the total film weight which is obtained by weighing the substrate before and after sputtering. Alternately, composition may be determined destructively by atomic absorption utilizing films dissolved from platinum substrates. (auth)

44326 SPECTROGRAPHIC DETERMINATION OF TRACES OF TELLURIUM. Marks, J.; Cone, R.; Leao, E. (Pratt and Whitney Aircraft, Middletown, Conn.). Appl. Spectrosc.; 25: No. 4, 493-6(Jul-Aug 1971).

A spectrographic method for the determination of as little as 0.3 μg tellurium in nickel-base alloys was developed. The method utilizes a preliminary separation and concentration of tellurium by precipitation of the metal with stannous chloride. The precipitate is then filtered and the filter paper ashed in the spectrographic electrode. Tellurium is measured by a dc arc technique. (auth)

44327 AUTOMATED PHOTOMETRIC ANALYSIS: A FURTHER STEP IN RATIONALISING THE METALLURGICAL LABORATORY. Koenig, Paul; Schmitz, Karl-Heinz; Thiemann, Erwin (Mannesmann AG, Duisburg, Ger.). Arch. Eisenhuettenw.; 41: No. 3, 227-30(1970). (In German).

Equipment is described for the determination of Si and Mo in steel and of citric acid-soluble phosphate in basic slag. Flow diagrams are presented. (Anal. Abstr.)

44328 POLAROGRAPHIC METHODS OF DETERMINING MOLYBDENUM. Maksimova, V. N.; Stashkova, N. V. Tr. Vses. Nauch.-Issled. Inst. Stand. Obraztsov Spektr. Etalonov; 5: 91-7(1969). (In Russian).

The polarographic reduction of Mo in solutions of acetic, citric, oxalic, nitrilotriacetic, tartaric, and ethylenediaminetetraacetic acids and H_3PO_4 is studied. The best-defined waves are obtained in citric acid solutions, in which medium a wide range of pH (1.5 to 3.5) can be used and the height of the wave remains constant. There is no interference from, e.g., V or W. Dissolved O may be removed with ascorbic acid. (Referativnyi Zh.)

44329 DETERMINATION OF MOLYBDENUM, TUNGSTEN, TANTALUM, AND NIOBIUM IN MULTI-ELEMENT ALLOYS BY X-RAY FLUORESCENCE. Schneider, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Z. Erzberbau Metalhuettenw.; 22: No. 7, 338-40(1969). (In German).

Solution methods can be used successfully for these alloys provided that the acid concentration is controlled. Alloys of Mo–W, Fe–W, and Fe–Nb–Ta are dissolved in mixtures of HNO_3 and HF, and Fe–Mo in HNO_3–H_3PO_4 and HF. Calibration graphs are prepared from solutions of the pure metals in the appropriate acid mixture. (Anal. Abstr.)

44330 DETERMINATION OF SCANDIUM IN TECHNICAL IRON. Engel, Oleg; Kral, Stanislav (SONP, Kladno, Czech.). Hutn. Listy; 25: No. 2, 124-5(1970). (In Czech).

Two methods were found to be suitable for the determination of Sc (0.5 to 1.0%) in Fe–Sc–S alloys. In the first method, Fe is separated by electrolysis on a mercury cathode, and Sc is precipitated as the hydroxide and weighed as Sc_2O_3; the method is suitable for alloys prepared from the pure metals. For alloys containing Al, Ti, Mo, and some other elements as impurities, Sc is precipitated by means of $Na_2S_2O_3$ solution and then reprecipitated as the hydroxide. A correction must be made for traces of oxides of Fe, Al, and Ti present in the weighed Sc_2O_3. (Anal. Abstr.)

44331 ELECTROPHORESIS OF LANTHANIDE ELEMENTS AND OF YTTRIUM, SCANDIUM, THORIUM, URANIUM, AND ZIRCONIUM IN LACTIC ACID MEDIA. Moura, M. M. L.; Guedes de Carvalho, R. Rev. Port. Quim. (Lisbon); 11: No. 1-4, 22-5 (1969). (In Portuguese).

The separation of these elements by electrophoresis at 11 V per cm in lactic acid electrolyte on Whatman No. 1 paper was examined. The spots were always cationic, the length of the spots decreased with concentration of electrolyte, and the optimum concentration of lactic acid was 0.7M. Separations on anion-exchange paper (Whatman ET 20) showed some advantages, but those on cation-exchange paper were of no value. Partially neutralized lactic acid media were also used, and the minimum lactate con-

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centration necessary to change the sign of the predominant electrophoretic species was established. Results are compared with those previously obtained with use of glycollic acid. (Anal. Abstr.)

44332 COMPLEXOMETRIC DETERMINATION OF THE MAIN METAL COMPONENTS OF INDIUM, LANTHANUM, ZIRCONIUM, AND VANADIUM SALTS, AND OF GALLIUM OXIDE AND SCANDIUM. Shafran, I. G.; Partashnikova, M. Z.; Pletneva, T. I.; Kon'kova, O. V. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov; No. 31, 212-21(1969). (In Russian).

Direct titration with EDTA solution is recommended for determining In in its salts, for Zr in its nitrate, or for Sc; the titrations are carried out at pH 3.0, 2.0, or 1.0, respectively, with Xylenol Orange as indicator. For La and V in their salts, or for Ga in its oxide, back-titration procedures are recommended; the titrations are carried out at pH 9.5 to 10 (for La and V) or 5.5 (for Ga), with Zn solution as titrant for unconsumed EDTA and with sulpharsazen {5-nitro-2-[3-(4-p-sulfophenylazophenyl)triazeno]benzenearsonic acid}, catechol Violet, or Xylenol Orange as indicator (for La V, or Ga, respectively). For Zr in salts other than the nitrate, the suggested procedure involves back-titration with Fe^{3+} solution at pH 5.5 (sulfosalicylic acid as indicator). (Referativnyi Zh.)

44333 VOLUMETRIC DETERMINATION OF TITANIUM IN ITS ALLOYS WITH NIOBIUM. Slama, Jaromir (State Research Inst. of Materials, Prague). Hutn. Listy; 25: No. 2, 132-4(1970). (In Czech).

The Ti in the test solution is reduced in a zinc reductor in the presence of HF, which prevents simultaneous reduction of Nb, and is then determined by titration with $FeCl_3$ solution in an atmosphere of CO_2 with methylene blue as indicator. (Anal. Abstr.)

44334 CHEMICAL ANALYSIS OF ZIRCONIUM ALLOYS. Musil, Josef. Hutn. Listy; 25: No. 3, 194-5(1970). (In Czech).

Procedures for the determination of Zr, Al, and Fe are described. Methods for the analysis of Ni–Zr alloys, mostly based on EDTA titration, are also described. (Anal. Abstr.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 44476, 44630, 44647, and 44814.

44335 (CONF-650616-33) ROUTINE DETERMINATION OF ^{239}Pu IN FUSED SOIL LATTICES BY TRACER TECHNIQUES. (Trapelo/West, Richmond, Calif.). [1965]. Contract DA-49-146-XZ-192. 21p. (TLW-1107). Dep. NTIS.

From Health Physics Society annual meeting; Los Angeles (14 Jun 1965).

A precision tracer procedure for the rapid determination of nonuniformly distributed ^{239}Pu in fused soil matrices up to 50 grams was developed. Samples consisting of bulk soils or soil particulates collected by various types of coring tools, impactors, filters, tapes, films, and trays were assayed for ^{239}Pu content. The basic steps were dissolution, tracer equilibration, purification, and electrodeposition. The samples were dissolved in HNO_3, HF, and $HClO_4$ to prepare a stock solution of each sample. This provides for complete solubilization of samples and avoids losses often associated with fusion techniques. An amount of ^{236}Pu tracer was added either to the dissolution mixture or to a sample aliquot to match, within broad limits, the expected ^{239}Pu content of the sample. Each solution was treated to ensure equilibration of sample plutonium with the tracer. The plutonium isotopes were then separated from the bulk of matrix elements by extraction into cupferron–chloroform of coprecipitate with $Fe(OH)_3$ and further purified with anion exchange resins. The purified fraction was electrodeposited on a platinum disc for alpha pulse height analysis. Tracer yield and ^{239}Pu content were determined from the spectrum. The precision tracer method ensures a high degree of accuracy, high sensitivity, and freedom from interference from other alpha emitters. The technique was used successfully for the plutonium assay of over 2600 samples. A typical chemical yield was 70% and the counting precision was within 3%. Limits of detection were approximately 0.05 dis/min for a thousand-minute count. (auth)

44336 (EURFNR-872) DETERMINATION OF ^{232}U AND ^{236}Pu IN IRRADIATED NUCLEAR FUELS. Braun, H.; Moy, T. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translation of report KFK-1128. 21p. (EUR-4320). Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this report, prepared from the original language, appeared as NSA 25: 23421. (auth)

44337 (MLM-1825) CONTRIBUTION TO THE DOSIMETRY OF TRITIUM IN THE PRESENCE OF INACTIVE AND ACTIVE GASES. Soudain, Georges (Mound Lab., Miamisburg, Ohio). 9 Jun 1971. Contract AT-33-1-GEN-53. 85p. Dep. NTIS.

Study of the physical and technological problems presented by the dosimetry of tritium in the air in the hydrogen molecule state or tritiated water vapor state made it possible to determine the nature of the equipment that would be best adapted for measurement and to select materials most appropriate for its construction. A method was tested that makes it possible to calibrate the device under conditions very similar to those of its continuous operation. The device is suitable for dosimetry of the total amount of tritium in the air. The ionization chambers adopted make it possible to estimate only half of the maximum permissible concentration of tritiated water. The differential system with two separate chambers does not provide for complete compensation of the ionization current generated by a stray γ field in all cases. For certain particular applications, a method for determining the total amount of tritium in the presence of other active gases was developed, which involves an ionization chamber and an end-window G–M counter mounted in the wall of the latter. The tritium concentration is derived from the difference between the ionization current and the current delivered by the integrator located in the electronic circuit of the counter. The measurement sensitivity depends on the concentration of contaminants other than the tritium. The use of stainless steel makes it possible to construct ionization chambers that have a very small storage effect, are easy to disassemble and, possibly, to decontaminate. (auth)

44338 (NYO-844-84, pp 12-20) ALPHA SPECTROSCOPY OF URANIUM IN TEKTITES. Kan, Nancy (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

An attempt was made to determine as accurately as possible the $^{234}U/^{238}U$ ratios in tektites from various localities as a means of testing the hypothesis of origin from terrestrial soils. The traces of uranium present are isolated chemically and the $^{234}U/^{238}U$ activity ratio determined by α spectrometry. (M.C.G.)

44339 DETERMINATION OF ^{14}C, ^{3}H, AND ^{35}S IN RUBBER VULCANIZATES. A NEW DEGRADATION METHOD FOR LIQUID SCINTILLATION COUNTING. Chapman, David A.; Parks, Carl R. (Goodyear Tire and Rubber Co., Akron, Ohio). Anal. Chem.; 43: No. 10, 1242-5(Aug 1971).

A new in-vial degradation method was developed in the preparation of rubber vulcanizates containing labeled accelerators or sulfur for liquid scintillation counting. Vulcanizates containing ^{14}C, ^{3}H, or ^{35}S are degraded directly in counting vials by tert-butyl hydroperoxide in p-xylene solution using osmium tetroxide as a catalyst. This procedure is less time consuming and compares favorably with older combustion methods in accuracy and precision of measurement. The procedure may also be used for dual labeled systems such as ^{3}H-labeled accelerator and ^{35}S. An alternative method of analysis using vulcanizate films is also described. (auth)

44340 Th MICROANALYSIS USING FISSION TRACKS. Hair, M. W.; Kaufhold, J.; Maurette, M.; Walker, R. M. (Washington Univ., St. Louis). pp VI.26-33 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A method for Th determination based on the fission track production rates observed in sequential irradiations of an unknown with 30-MeV α particles and thermal neutrons was previously described. Improved techniques for this method are reported. Measurements of U.S.G.S. standard powdered rock samples indicate an absolute accuracy of less than 10% for concentrations greater than 0.1 ppM. This conclusion is verified by further comparisons based on specially fabricated trace Th glasses and certain natural obsidian samples. The technique that was used also measures the U concentration of the unknowns. Working with obsidian artifacts and obsidian mine samples from the Aegean region, U–Th groupings that agree with previous groupings that were based on Ba and Zr analyses were found. The advantage of the fission track methods for Th determination is the ability to make absolute determinations on very tiny samples and to do micromapping of the Th distribution in larger samples. As an example, some of the powdered rock standards were found to be inhomogeneous on a microscale giving rise to sunburst patterns of fission tracks. (France)

44341 LEXAN PLASTIC PRINTS: HOW ARE THEY FORMED. Kleeman, J. D.; Lovering, J. F. (Australian National Univ., Canberra). pp VI.41-52 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Lexan plastic prints are formed when a rock section is irradiated, with a sheet of plastic held against it, in a predominantly thermal neutron flux. The print texture is made up of varying densities of tiny etch pits, which are formed when the plastic is chemically etched after irradiation. The pits are formed from short trails caused by the passage of either alpha-particles or recoil ions from the rock material. Observed pit densities are correlated with the mineral phases producing them, and calculations of the elemental concentration of B, Li and O required to produce them are made. The present ideas of the print formation are compared with a previous suggestion that they are produced by recoiling OH ions. (auth) (France)

44342 USE OF CELLULOSE NITRATE IN CONTROLLING THE ENRICHMENT OF METALLIC URANIUM. Chapuis, Anne-Marie (CEA, Fontenay-aux-Roses, France); Francois, Henri; Gerard-Nicodeme, Nicolo. pp IX.34-46 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Cellulose nitrate can be used to detect the passage of α particles and hence to measure the specific activity of a thick radioactive source. This property is used to measure the degree of enrichment in ^{235}U of a metallic uranium sample. In order to facilitate the measurements and to count the number of α tracks with an optical microscope, the samples were developed in a special bath and the number of tracks per unit area was evaluated as a function of the reflecting power of the sample. The time and costs involved using this method are greatly reduced. The protection associated with the storing of fissionable materials necessitates a simple and rapid control of ^{235}U enrichment. Various methods of dose measurement are available; measurement of sample α activities was chosen. In the apparatus described, an ionograph detector insensitive to light and with a reduced β particle and electromagnetic radiation sensitivity was used. (France)

Activation Procedures

Refer also to abstracts 44818, 45862, 45885, 45943, and 46342.

44343 DETERMINATION OF NOBLE METALS BY NEUTRON-ACTIVATION ANALYSIS. Gijbels, R. (State Univ., Ghent). Talanta; 18: No. 6, 587-601(Jun 1971).

The scope and limitations of neutron activation analysis in the field of the platinum metals are discussed. Special attention is given to interferences that occur in determination of noble metals in platinum metals and in natural samples. The problems of standards, carriers, and chemical yield determination are emphasized. A recommendation is given of modern techniques for counting radionuclides formed by neutron activation of the platinum metals. (auth) (UK)

44344 DETERMINATION OF IODINE AND BROMINE IN BIOLOGICAL MATERIALS BY NEUTRON-ACTIVATION ANALYSIS. Ohno, S. (National Inst. of Radiological Sciences, Chiba, Japan). Analyst: 96: No. 1143. 423-6(Jun 1971).

Iodine and Br were determined in some biological materials by neutron activation analysis. These elements were extracted from irradiated samples with a 5% solution of trioctylamine in xylene. First the bromine was back-extracted with N sodium nitrate solution and then the iodine was back-extracted with N ammonia solution. The extraction yield was about 94% for I and about 86% for Br. The limit of detection is about 0.01 μg for I and about 0.1 μg for Br. The precision of the method is about ±6% for both elements for concentrations exceeding 0.1 ppM. (auth) (UK)

44345 PHOTOACTIVATION ANALYSIS OF AN ANTIMONY–PHOSPHORUS ION EXCHANGER. Kotel'nikov, L. A.; Kuznetsov, R. A. Vestn. Leningrad. Univ., No. 22, Fiz. Khim.; No. 4, 137-40(Nov 1970). (In Russian).

Nondestructive determination of oxygen, phosphorus, and antimony in the SbP ion exchanger by photon activation is proposed. The samples were irradiated with 25-MeV bremsstrahlung. The induced activity is measured by the β^+ scintillation spectrometer. The precision of the method is 10% for oxygen, 7% for phosphorus, and 5% for antimony. (auth)

44346 RADIOACTIVE METHOD FOR DETERMINING INDIUM AND GALLIUM IN WATER. Sharinov, E. B.; Khudaiberganov, U. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 6, 55-6(1970). (In Russian).

Indium-116 and ^{72}Ga possess relatively large cross sections for a (n,γ) reaction. Samples of water were placed in a neutron flux of 1.8×10^{13} n/cm^2/sec for approximately an hour. After evaporating down with HBr, the residue was taken up in 6N HBr and extracted with ether. Further chemical separations were made and the two samples obtained were finally counted in a gamma-scintillation counter. Yields of In and Ga from the chemical treatment and separation were found to be approximately 85 and 90%, respectively. (K.S.W.)

44347 SIMPLE, RELIABLE BASIC EQUATION FOR PROTON-REACTION ANALYSIS OF BIOLOGICAL MATERIALS. Ricci, E. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 94: No. 3, 565-72(1971).

Charged-particle reaction-analysis calculations are naturally intricate because, unlike neutrons and photons, these particles readily lose energy when they penetrate matter and, therefore, the nuclear-reaction cross section varies with sample depth; in consequence, the usually significant variations among stopping powers of different substances — and, particularly, between samples and standards — must be taken into account to avoid systematic errors in the results. Observed regularities in organic substances, however, have led to the derivation from first principles of a simple, sufficiently accurate basic equation $(R/R') = (F/F')(C/C')$, which gives either the ratio F between two isotopic abundances or the ratio C between two elemental concentrations, for organic samples, in terms of the corresponding nuclear-reaction prompt-product yield ratio R, and of the analogous parameters F′, C′ and R′ for a known standard. The equation was derived, and proved reliable, for the determination of the isotopic abundance ratio $^{13}C/^{12}C$ that leads to ^{12}C and ^{13}C percent isotopic abundances and of the elemental ratio N/C by low-energy proton bombardment of biological samples with simultaneous prompt-gamma spectrometry. As analogous simplifying conditions may predictably be met in many charged-particle reaction analyses conducted by the comparator method, however, the same derivation and basic equation could be applicable on a general basis. (auth)

44348 TOPOGRAPHICAL DISTRIBUTION OF IMPURITIES IN CRYSTALLINE QUARTZ BY A RADIOACTIVATION METHOD. Vakhidov, Sh. A.; Gasanov, E. M.; Khatamov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 77-80(1970). (In Russian).

Quartz lends itself well to activation analysis since interaction of thermal neutrons with the matrix elements Si and O yields relatively short-lived radioisotopes. Using autoradiograms in conjunction with activation analysis, the concentration and distribution of separate admixed elements in different zones and areas could be accurately determined in synthetic and natural quartz samples. Synthetic quartzes were prepared with added Al, Ge, and some alkali metals, and the radioactivity distribution and decay was studied with a gamma-spectrophotometric counter and multichannel analyzer. The autoradiograms furnished evidence of induced coloration of the quartz samples, and helpful information concerning the conditions of crystal growth. (K.S.W.)

44349 UTILIZATION OF THE MATRIX AS A STANDARD IN TRACE ANALYSIS BY NEUTRON ACTIVATION ANALYSIS. ANALYSIS OF CADMIUM DOPED SODIUM CHLORIDE CRYSTALS. Heurtebise, M.; Lubkowitz, J. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Anal. Chem.; 43: No. 10, 1218-21(Aug 1971).

The possibility of analyzing a trace impurity in a matrix by utilizing a matrix component as standard was investigated. The method was developed to minimize errors due to flux deviations, counting geometry, and standard preparations. Equations were derived that directly relate the concentration of the impurity to the time of decay after irradiation when equal activity due to a matrix component and impurity are obtained. The principle was applied to the analysis of Cd-doped sodium chloride crystals. The method showed a standard deviation of 4.1%. Crystals of up to 100 mg having Cd/Na ratios of 2×10^{-5} were analyzed. (auth)

44350 USE OF ANION EXCHANGE RESIN-LOADED PAPER IN THE DETERMINATION OF TRACE MERCURY IN WATER

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BY NEUTRON ACTIVATION ANALYSIS. Becknell, D. E.; Marsh, R. H.; Allie, William Jr. (Ford Motor Co., Dearborn, Mich.). Anal. Chem.; 43: No. 10, 1230-3(Aug 1971).

A neutron activation analysis method was developed for determination of mercury in water at levels of 0.05 to 250 μg. A pre-irradiation concentration of Hg is accomplished through the use of anion exchange resin-loaded filter disks. Hydrochloric acid is added to the water sample and mercury, as $HgCl_4^{2-}$, is removed from the solution by an exchange technique. Following the concentration of Hg in the resin the samples are irradiated and the Hg content is determined using a standard comparison technique on the 77-keV gamma ray from the decay of ^{197}Hg. In solutions containing up to 250 μg of Hg, 100% of the Hg is removed by the anion exchange technique. A chlorine treatment is used to degrade organomercury compounds. The method was applied to a variety of natural water samples, the compositions of which varied from 0.03 to 6.6 ppB of mercury. (auth)

44351 RADIOISOTOPE NEUTRON ACTIVATION FOR ON-STREAM PROCESS ANALYSIS. Rhodes, J. R. (Columbia Scientific Research Inst., Austin, Tex.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 81-7(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

The high penetration of incident neutrons and emitted gamma rays makes nuclear techniques well suited to on-stream analysis in industrial conditions. The availability of neutron emitting radioisotope sources, particularly ^{252}Cf, makes possible the manufacture of relatively inexpensive, rugged, and reliable process analyzers. Current progress in development of techniques and instrumentation is reviewed. (auth)

44352 COMPARISON OF POLY(VINYL CHLORIDE)-COATED SAMPLES OF COPPER CABLE BY NEUTRON-ACTIVATION ANALYSIS. Caldwell, R. J. (Commonwealth Police Force, Kingston, Australia). J. Forensic Sci. Soc.; 10: No. 2, 69-72 (1970).

Samples of 5 to 10 g were irradiated for three days in a thermal-neutron flux of $\simeq 5 \times 10^{12}$ neutrons/cm^2/sec, set aside for ≃14 or 30 days and then counted for γ activity on a 6 × 6 cm Ge(Li) detector coupled to a 1024-channel analyzer to determine Ag, Au, Co, Sb, Sc, Se, and Zn. The coatings were separated and irradiated for 1 hr and, after ≃6 hr, counted as above, or with use of a NaI(Tl) detector and 512-channel analyzer, to determine Na, Br, La, Cr, Sc, Sb, Cu, and Th. It was possible to identify sources of copper wire by comparison of the trace elements present, but results for the coatings were more variable. (Anal. Abstr.)

44353 INDUSTRIAL APPLICATIONS OF ACTIVATION ANALYSIS WITH 14 MeV NEUTRONS. Wood, D. E. (Kaman Sciences Corp., Colorado Springs). Nucl. Instrum. Methods; 92: No. 4, 511-15(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Recent developments in equipment and techniques have facilitated industrial applications of neutron activation analysis with 14-MeV neutrons. A number of examples are given that show its use in sample analysis systems, on-line systems, and in- situ analysis. (R.W.R.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 44794.

Chemical Properties

Refer also to abstracts 44402 and 44411.

44354 DISPROPORTIONATION OF QUINQUEVALENT NEPTUNIUM IN NITRIC ACID SOLUTION. I. EQUILIBRIUM STUDIES. Escure, H. (CEN, Fontenay-aux-Roses, France); Gourisse, D.; Lucas, J. J. Inorg. Nucl. Chem.; 33: No. 6, 1871-6(Jun 1971). (In French).

Disproportionation of neptunium(V) in nitric and perchloric acid solutions was studied by spectrophotometric measurements. For a given acid concentration the apparent mass action law constant is higher in nitric than in perchloric acid solution. The difference between the two apparent constants decreases as acidity increases. Using water and acids activity values, it was shown that these variations result of two opposite effects with increasing acid concentration; decrease in ionization of acids, (perchloric acid is stronger than nitric acid), increase in complexation of neptunium(IV) and (VI) by acid anions (nitrate anion has a stronger complexing power than perchlorate anion). (auth) (UK)

44355 ACTION OF ALIPHATIC AMINES ON THORIUM DIOXALATE. Molodkin, A. K.; Balakaeva, T. A.; Kuchumova, A. N. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 5, 1301-3(May 1971). (In Russian).

Thorium dioxalate hexahydrate completely dissolves in an excess aliphatic amine–oxalic acid mixture with subsequent precipitation of compounds of the following composition: $[(CH_3)_2NH_2]Th(C_2O_4)_4 \cdot 2H_2O$(I); $[(C_2H_5)_2NH_2]_6Th_2(C_2O_4)_7 \cdot 6H_2O$(II); $[(C_3H_7)_2NH_2]_6Th_2(C_2O_4)_7 \cdot 8H_2O$(III); $[(C_3H_7)_2NH_2]_4Th(C_2O_4)_4 \cdot 2H_2O$(IV); $[(C_4H_9)_2NH_2]_4Th(C_2O_4)_4 \cdot 4H_2O$(V); $[(C_4H_9)_2]_8Th(C_2O_4)_8$(VI); $[(C_2H_5)_3NH]_8Th(C_2O_4)_6 \cdot 3H_2O$(VII). All of the compounds listed are colorless, crystalline materials stable in air (VI and VII dehydrate easily). The refractive index and density of each was determined. I to VII are soluble in water; V, VI, and VII are also soluble in alcohol. On heating, these compounds first lose water, then the amine, to form ThO_2. (K.S.W.)

44356 COMPOUNDS OF THORIUM TETRANITRATE WITH THE NITRATES OF ALIPHATIC AMINES. Molodkin, A. K.; Ivanova, O. M.; Belyakova, Z. V. Zh. Neorg. Khim.; 16: No. 5, 1461-2(May 1971). (In Russian).

Penta- and hexanitrate complexes of Th with the forms $AmHTh \times (NO_3)_5 \cdot nH_2O$ and $(AmH)_2Th(NO_3)_6$, where AmH is one of the alkylammonium cations: $CH_3NH_3^+$, $(CH_3)_2NH_2^+$, $C_2H_5NH_3^+$, or $(C_2H_5)_2NH_2^+$, were prepared. A solution of $Th(NO_3)_4$ and amine nitrate maintained in a vacuum desiccator above KOH forms the desired complexes as colorless prisms, density 2.00 to 2.50 g/cm^3. The electric conductivity of solutions of the two methylamine complexes are reported at various concentrations in H_2O and methanol. (K.S.W.)

44357 RELATIVE OXIDATION POTENTIALS OF THE Bk(IV)–Bk(III) AND Ce(IV)–Ce(III) COUPLES IN ACID SOLUTIONS. Weaver, Boyd (Oak Ridge National Lab., Tenn.); Stevenson, J. N. J. Inorg. Nucl. Chem.; 33: No. 6, 1877-81(Jun 1971).

The differences in formal oxidation potentials of the Bk(IV)–Bk(III) and Ce(IV)–Ce(III) couples in a wide range of concentrations of nitric and perchloric acids were measured by a solvent extraction method that separates the Bk(IV) from the Bk(III) present in equilibrium with a Ce(IV)–Ce(III) mixture of predetermined composition in an aqueous solution. The differences in potential were then calculated from a form of the Nernst equation. In nitric acid Ce(IV) was the stronger oxidant in all concentrations of acid below about 7.5N HNO_3, with a maximum difference of ~0.08V in 2N HNO_3. In perchloric acid the maximum difference was ~0.11V in 4N $HClO_4$, with differences of ~0.08V in 1N and 8N $HClO_4$. Attempts to measure potential differences in sulfuric and phosphoric acids by this method were unsuccessful because of strong complexing in the aqueous solutions. (auth) (UK)

44358 STUDIES ON THE DISPROPORTIONATION REACTION OF PENTAVALENT URANIUM BY THE ROTATING DISK-RING ELECTRODE METHOD. Nekrasov, L. N.; Potapova, E. N. (Moscow State Univ.). Elektrokhimiya; 6: No. 6, 806-11(Jun 1970). (In Russian).

The disproportionation reaction of pentavalent uranium was studied in solutions of sulfuric acid and perchloric acid by the rotating disc–ring electrode technique. A polarization curve consisting of two waves was obtained at the gold ring electrode. The first wave corresponded to oxidation of U(V) synthesized at the disc electrode; the second wave represented the oxidation of U(IV), originating from the disproportionation of UO_2^+. It was established that disproportionation of UO_2^+ takes place both in the bulk of the solution and at the electrode surface. The surface reaction, in contrast to the former, depends somewhat on the acidity of the medium, and is a first order reaction with respect to the U concentration. The character of the relation between the disc/ring current ratio and the rotational speed of the electrode may serve as a criterion for the difference between the surface chemical reaction (half-product disappearance) and the bulk solution reaction. (tr-auth-INIS)

Isotope Effects and Exchange

Refer also to abstracts 44396 and 44417.

44359 (LA–4689) ROLES OF CHLORINE AZIDE IN CHEMICAL LASERS. Rice, Walter W. Jr. (Los Alamos Scientific Lab., N. Mex.). Jun 1971. Contract W-7405-eng-36. 154p. Dep. NTIS.

Thesis.

ClN_3 was photolyzed in various gas mixtures to transform its chemical energy into laser radiation. Reaction mechanisms, energy distribution in reaction products, and relative reaction rates were deduced from the laser emission. Flash photolysis of ClN_3–H_2 mixtures produced HCl laser emission. The effects of chlorine-37 on this process were studied. Chlorine azide was examined as a source of excited $N_2(v > 0)$ in a CO_2 laser system. The explosion of ClN_3 was used to drive an HF chemical laser by thermally dissociating NF_3 or SF_6 to produce F for the $F + H_2 \rightarrow HF^* + H$ reaction. At high pressures laser emission was parasitized by isotropic superradiance. The energy output was dependent on the rate of energy deposition from both flash lamp and ClN_3 explosion. (auth)

44360 THERMODYNAMICS OF ISOTOPE EXCHANGE OF MIXED FLUORIDES, CHLORIDES, AND BROMIDES OF BORON. Romashko, B. V.; Maslov, P. G.; Chichikalyuk, E. M.; Fedorova, T. A. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 1, 36-40 (Jan 1971).

Translated from Zh. Prikl. Khim.; 44: No. 1, 39-43(Jan 1971).

Data given in a number of publications were used for calculating the temperature dependence of the logarithms of chemical equilibrium constants for 42 isotope exchange reactions of mixed boron halides. The relations were valid in the 250 to 1500°K temperature range with an accuracy of the order of 0.01 to 1%. (M.C.G.)

44361 ISOTOPE EFFECTS IN COUNTERCURRENT ELECTROMIGRATION IN MOLTEN METAL HALIDES. Kanno, H. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 33: No. 6, 1561-8(Jun 1971).

The mass effects of Li^+, K^+, and Rb^+ in molten LiBr, KBr, RbBr, and RbI were measured. New empirical formulas presented by Saito and Kanno, which correlated the cationic mass effects of metal halides with the ionic radius ratio r^+/r^- of the salt, were developed and interpreted qualitatively in terms of ionic entities in the melt. (auth) (UK)

44362 RAMAN SPECTRA OF THE PERCHLORATES OF Zn, Cd, Hg, AND Pb in H_2O AND D_2O SOLUTIONS. Myund, L. A.; Latysheva, V. A.; Glebovskii, D. N.; Dmitrieva, E. S. Vestn. Leningrad. Univ., No. 22, Fiz. Khim.; No. 4, 80-3(Nov 1970). (In Russian).

The Raman spectra of Zn, Cd, Hg, and Pb perchlorates in concentrated H_2O and D_2O solutions in the frequency range from 300 to 3000 cm^{-1} were investigated. Assignment suggested previously was confirmed. It is supposed that correlation between force constants of Me–O bonds and cation hydration energies takes place only within a certain group of the periodic system. (auth)

44363 ISOTOPIC RELATIONSHIPS BETWEEN CENTRIFUGAL DISTORTION CONSTANTS OF POLYATOMIC MOLECULES. Aleksandrov, A. P.; Aliev, M. R.; Aleksanyan, V. T. Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 6, 568-71(Dec 1970).

Translated from Opt. Spektrosk.; 29: No. 6, 1064-9(Dec 1970).

Product and sum rule relationships were obtained between the centrifugal distortion constants of polyatomic molecules. A number of specific molecular models are considered. (auth)

44364 ISOTOPE EFFECT IN THE INFRARED SPECTRUM OF SF_6. Klimov, V. D.; Lobikov, E. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 1, 25-8(Jan 1971).

Translated from Opt. Spektrosk.; 30: No. 1, 48-53(Jan 1971).

The infrared spectrum of gaseous SF_6 with a natural isotope composition and SF_6 enriched with ^{33}S, ^{34}S, and ^{36}S was investigated in the 400 to 5,000-cm^{-1} and 400 to 1,800-cm^{-1} intervals, respectively. The isotope shifts for the frequencies ν_3 and ν_4 and the combination frequencies $(\nu_2 + \nu_3)$, $(\nu_1 + \nu_4)$ were measured. The following basic ν_3 and ν_4 frequencies of SF_6 were obtained: ν_3; $^{32}SF_6$, 947; $^{33}SF_6$, 939; $^{34}SF_6$, 930; $^{36}SF_6$, 914 cm^{-1}; ν_4; $^{32}SF_6$, 615; $^{33}SF_6$, 613; $^{34}SF_6$, 612 cm^{-1}. The force constants for the SF_6 molecule were calculated with the experimental data. (auth)

44365 DETERMINATION OF ^{32}P AND ^{33}P IN AQUEOUS SOLUTION. Brown, L. C. (Oak Ridge National Lab., Tenn.). Anal. Chem.; 43: No. 10, 1326-8(Aug 1971).

A routine analytical procedure based on a combination of Cherenkov radiation counting and liquid scintillation counting was devised and tested. This procedure is rapid, requires only one counting system, can be easily automated for routine multiple analysis, and yields high accuracy. The ^{32}P content of a sample was determined directly from the Cherenkov radiation counting data, whereas the ^{33}P content was determined from the liquid scintillation counting data by difference. (M.C.G.)

44366 ISOTOPE EFFECT IN DIFFUSION OF INTERSTITIAL ATOMS. Murtazin, I. A. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 136-40(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 172-7(Jan 1971).

A relation is derived for the measured isotope effect in the classical case at high temperatures. The calculations are performed for the interstitial diffusion mechanism in a simple cubic lattice. Mullen's coefficient, ΔK, is found to take account of the change in the vibration spectrum that occurs in an elementary act of diffusion. The harmonic approximation is used to analyze the spectrum with an atom at an interstice using two-time Green's functions when the constants for the central and other interactions are equal to each other. (auth)

Physical Chemistry

Refer also to abstracts 45588, 45601, 46279, 46282, 46305, and 46374.

44367 (ANL–7821) CHEMICAL ENGINEERING DIVISION, THERMOCHEMICAL STUDIES SEMIANNUAL REPORT, JANUARY–JUNE 1971. Hubbard, W. N.; O'Hare, P. A. G.; Johnson, G. K.; Ader, M.; Settle, J. L.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 24p. Dep. NTIS.

Preliminary values for enthalpies of formation were determined as follows: $\Delta Hf^\circ_{298}(Na_3UO_4, c)$ = approx. –480 kcal $mole^{-1}$; $\Delta Hf^\circ_{298}(Na_2O, c) = -99.14 \pm 0.05$ kcal $mole^{-1}$; $\Delta Hf^\circ_{298}(CsHC_2, c) = +18.60 \pm 0.21$ kcal $mole^{-1}$; and $\Delta Hf^\circ_{298}(XeF_6, c) = -80.85 \pm 0.67$ kcal $mole^{-1}$. Exploratory studies were started on ThS. A high-purity sample of technetium is being prepared for determinations of $\Delta Hf^\circ(TcF_6)$ and $\Delta Hf^\circ(Tc_2O_7)$. The effect of CO_2 in the HCl solution on the enthalpy of the HCl–tris (hydroxymethyl) aminomethane reaction was studied. (auth)

44368 (ORNL–4708) EXTENSION OF THE RADIOMETRIC POROUS-FRIT METHOD TO THE MEASUREMENT OF DIFFUSION COEFFICIENTS OF NON-RADIOACTIVE COUNTERIONS IN ION-EXCHANGE MEMBRANES. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 17p. Dep. NTIS.

A way is suggested by which the porous-frit method may be used to measure the diffusion coefficients of nonradioactive counterions in ion-exchange membranes. The nonradioactive counterion is used to elute a radioactive counterion of known diffusion coefficient from the membrane. The transient, rather than the asymptotic, time behavior of the membrane activity is recorded. (auth)

44369 URANIUM–FLUORINE LATTICE VIBRATION OF URANYL FLUORIDE. Ohwada, Ken (Japan Atomic Energy Research Inst., Ibaraki). J. Inorg. Nucl. Chem.; 33: No. 6, 1651-23(Jun 1971).

The infrared spectrum of uranyl fluoride, UO_2F_2, was measured in the frequency region from 4000 to 380 cm^{-1}. A normal coordinate analysis of the optically active U–O and U–F lattice vibrations was made on the basis of a layer model of infinite $[(UO_2)F_2]_\infty$. Based on the results of this treatment, some of the observed bands were assigned to the U–O and U–F lattice vibrations. The stretching and repulsive force constants were obtained and discussed. The infrared spectrum of neptunyl fluoride, NpO_2F_2, was also investigated from the same viewpoint. (auth) (UK)

44370 SELF-DIFFUSION OF TRACE CONCENTRATIONS OF ^{144}Ce, ^{147}Pm, AND ^{155}Eu IN WATER SOLUTIONS. J. Inorg. Nucl. Chem.; 33: No. 6, 1741-8(Jun 1971).

Self-diffusion coefficients of ^{144}Ce, ^{147}Pm, and ^{155}Eu in water solutions were determined as functions of pH at two ionic strengths $\mu = 0.01$ and 0.1. From the values of the self-diffusion coefficients and viscosity the ion and Ce(III), Pm(III), and Eu(III) colloid hydroxide radii were calculated. The values of the self-diffusion coefficients were within 10^{-6} to 10^{-7} cm^2/sec. The radii of colloidal particles of Ce(III), Pm(III), and Eu(III) hydroxides at μ = 0.1 were 37, 22, and 18 Å, respectively. (auth) (UK)

44371 SOME FEATURES OF THE STRUCTURE OF FUSION DIAGRAMS FOR FOUR ALKALI METAL CHLORIDE–URANYL CHLORIDE SYSTEMS AND THEIR X-RAY DIFFRACTION STUDY. Vorobei, M. P.; Skiba, O. V.; Bevz, A. S.; Kapshukov, I. I. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 1, 12-14(Jan 1971).

Translated from Zh. Fiz. Khim.; 45: No. 1, 22-5(Jan 1971).

Certain features of the structure of fusion diagrams for systems based on uranyl chloride and alkali metal chlorides were generalized as a function of the radius of the alkali metal cations. Complexes of the type $M(UO_2)_2Cl_5$ and $M_2UO_2Cl_4$ were investigated by x-ray diffraction; the parameters of their crystal lattices were calculated. (auth)

XUM

44372 INFRARED SPECTRUM OF MATRIX-ISOLATED URANIUM MONOXIDE. Abramowitz, S. (National Bureau of Standards, Washington, D. C.); Acquista, N.; Thompson, K. R. J. Phys. Chem.; 75: No. 15, 2283-5(22 Jul 1971).

The infrared spectra of matrix-isolated uranium oxides were observed. By varying the O/U ratio of the condensed phase from 1.5 to 3.0 and comparing the observed spectra of the matrix-isolated vapors in equilibrium with the condensed phases it was possible to assign a frequency of 776.0 cm^{-1} to $U^{16}O$. Verification of this assignment was obtained in similar experiments using oxygen-18-enriched uranium oxides; a frequency of 736.2 cm^{-1} was observed for $U^{18}O$. This yields a force constant to the harmonic approximation of 5.32 mdyn/Å for this species. A stretching mode of UO_2 was also assigned for $U^{16}O_2$, $U^{18}O_2$, and $U^{16}O^{18}O$. (auth)

44373 MISCIBILITY OF LIQUID METALS WITH SALTS. X. VARIOUS STUDIES IN ALKALINE EARTH METAL–METAL FLUORIDE AND RARE EARTH METAL–METAL DIFLUORIDE AND TRIFLUORIDE SYSTEMS. Dworkin, A. S.; Bredig, M. A. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 75: No. 15, 2340-4(22 Jul 1971).

The phase diagrams $Ba-BaF_2$, $Sm-SmF_2$, and $Yb-YbF_2$ were determined. The $Ba-BaF_2$ and $Yb-YbF_2$ systems are similar to $Ca-CaF_2$ in that they exhibit complete miscibility. In $Sm-SmF_2$, at 1216°C, a large miscibility gap extends from the liquid monotectic, 32 mole %, to almost 100% Sm. The solubilities of Mg in MgF_2, of La, Ce, and Nd in their respective trifluorides and of Th in ThF_4 were found to be very low, less than 0.5 mole %. Determination of the melting point depression of calcium metal caused by the dissolution of CaF_2 and of the solubility of CaF_2 in solid Ca metal yielded the not unexpected result that in the solution the fluoride ions form separate particles. (auth)

44374 HEATS OF DILUTION AND THE THERMODYNAMICS OF DISSOCIATION OF URANYL AND VANADYL SULFATES. Bailey, Allen R.; Larson, John W. (Marshall Univ., Huntington, W. Va.). J. Phys. Chem.; 75: No. 15, 2368-72(22 Jul 1971).

Heats of dilution of aqueous solutions of uranyl and vanadyl sulfates were measured. These data were used to calculate the heats of dissociation of their respective ion pairs. For the reaction $UO_2SO_4(aq) \rightleftharpoons UO_2^{2+}(aq) + SO_4^{2-}(aq)$, the results are $\Delta G^\circ = 3.71$ kcal mole/$\Delta H^\circ = -4.98$ kcal/mole, and $\Delta S^\circ = -29.1$ gibbs/mole. The corresponding results for $VOSO_4$ are $\Delta G^\circ = 3.38$ kcal/mole, $\Delta H^\circ = -4.12$ kcal/mole, and $\Delta S^\circ = -25.2$ gibbs/mole. The standard heat of solution of $UO_2(NO_3)_2 \cdot 6H_2O(c)$ was determined and the $\bar{S}_2^\circ$ of the $UO_2^{2+}(aq)$ ion calculated to be −23.1 gibbs mole. The partial molal entropies of the UO_2SO_4 and $VOSO_4$ ion pairs were calculated from these results and explained in terms of the primary hydration of these ion pairs. (auth)

44375 VOLATILITY RATES OF U_3O_8 PHASE IN DIFFERENT ATMOSPHERES AT HIGH TEMPERATURES. Chandrasekharaiah, M. S.; Sreedharan, O. M.; Dharwadkar, S. R. (Bhabha Atomic Research Centre, Trombay, India). pp 119-26 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

The carrier gas transport method was used to study the effects of moisture on the volatility of U_3O_8 above 1000°C. Preliminary data at 1300°C are presented, for which dry and wet oxygen was used as the carrier gas. (J.G.B.)

Radiation and Nuclear Chemistry

Refer also to abstract 44727.

44376 (AEC-tr-7102/4) NUKLEONIKA. Translation of Nukleonika; 15: No. 4, 317-416(1970). 94p. (TT-70-55010/4). Dep. NTIS.

44377 PROBLEM OF RADIOACTIVE CONTAMINATION ON CHEMICAL INSTALLATIONS. Chistov, E. D.; Osipov, V. E.; Sprygaev, I. F.; Solodikhina, L. D.; Dzhagatspanyan, R. V. Gig. Sanit.; No. 6, 76-80(Jun 1970). (In Russian).

Radioactive contamination of inactive spherical elements of an industrial radiation-chemical apparatus was substantially below the level permitted. Methods of encapsulation of sources and transfer of sources to decrease the probability of contamination are discussed. (tr-auth)

Radiation Effects

Refer also to abstract 44775.

44378 MICROSPECTROPHOTOMETER CELLS OF FUSED CONSTRUCTION. Carnall, W. T.; Fields, P. R. (Argonne National Lab., Ill.). Appl. Spectrosc.; 25: No. 4, 503(Jul-Aug 1971).

To investigate the absorption spectra of solutions containing radioactive species, a completely fused cell construction is required. Masking the ends of silica cells used could be avoided by using a less pure silica for the cell body and subjecting the entire cell to high-level γ radiation after fabrication. An exposure of 30 min was sufficient to blacken the body of the cell. The high-purity silica windows exhibited the same transmission before and after irradiation. (M.C.G.)

44379 MECHANISM OF THE RADIATION-INDUCED OXIDATION OF AV-18 ANION-EXCHANGE RESIN. Kiseleva, E. D.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 44: No. 10, 1443-6(Oct 1970).

The change in the chemical structure of AV-18 anion-exchange resins on irradiation with a beam of accelerated electrons at a dose of 1.2×10^{23} eV g^{-1} was investigated by means of ir spectral studies, and it was shown that this involves the oxidation and nitration of the macromolecular framework. (auth)

Radiation Processes

44380 APPLICATION OF RADIATION TO THE TREATMENT OF WASTE WATER. Machi, Sueo (Japan Atomic Energy Research Inst., Takasaki, Japan). Genshiryoku Kogyo; 17: No. 2, 45-50(Feb 1971). (In Japanese).

Treatment of polluted water by radiation is discussed. Effects of the radiation on drainage and sewage are considered, such as reduction in BOD and COD (biological and chemical oxygen demands), pollutants made decomposable biochemically, sedimentation enhanced by changing colloidal properties, etc. Operation of the radiation treatment plant in the United States, economy of the radiation treatment, and applications of radiation synthesis are described briefly. (Japan)

44381 STUDIES IN RADIATION POLYMERIZATION. XV. THE RADIATION POLYMERIZATION OF N-BENZYLMALEIMIDE. Ivanov, V. S.; Smirnova, V. K.; Boronoeva, T. R. Vestn. Leningrad. Univ., No. 22, Fiz. Khim.; No. 4, 151-4(Nov 1970). (In Russian).

Poly-N-benzylmaleimide was prepared by means of radioinduced polymerization (^{60}Co γ rays) in the solid state. The effect of radiation dose and temperature on the polymerization was studied. The sensitizing effect of trichloroacetic and trifluoroacetic acids on the radioinduced polymerization was demonstrated. For the poly-N-benzylmaleimide the data on solubility, intrinsic viscosity, softening and decomposition points, and ir absorption and x-ray spectra were obtained. (auth)

44382 ELECTRON CURING OF COATINGS: PRESENT STATUS. Hoffman, Allan S. (Univ. of Washington, Seattle). At. Energy Rev.; 9: No. 2, 347-71(Jun 1971).

The present status of electron curing of coatings is surveyed, and the chemical, radiation, engineering, and economic considerations analyzed. The curing mechanism is discussed from the standpoint dose, monomer concentration and composition, and reactivity, molecular weight, and composition of unsaturated polymer. (42 references) (J.G.B.)

44383 RADIATION CURING OF NATURAL RUBBER LATEX. Puig, Jean R. (CEA–CEN, Saclay, France). At. Energy Rev.; 9: No. 2, 373-97(Jun 1971).

Progress made in the radiation curing of rubber latex during the past ten years has resulted in a promising new technology. Low doses are required for the process, but a high dose rate can be used to give large production capacities. The properties of solid rubber made from irradiated latex are as good as those obtained from conventionally cured latex. However, the mechanisms underlying the process are not well understood, and additional research is needed. (auth)

44384 MODIFICATION OF PLASTICS BY CROSS-LINKING AND GRAFTING. Danno, A. (Japan Atomic Energy Research Inst., Takasaki). At. Energy Rev.; 9: No. 2, 399-422(Jun 1971).

Promising processes for the modification of plastics by cross-linking, such as cross-linked polyethylene, heat-shrinkable material, foamed polyethylene sheet, cross-linking of poly(vinyl chloride) and vulcanization of rubber latex are discussed. Several promising processes for radiation grafting, such as the modification of polyethylene by grafting, modification of poly(vinyl chloride) by grafting, grafting of vinylpyrrolidone onto polysiloxane, grafting of styrene onto cellulose acetate, modification of cellulose

fibers by grafting, grafting of poly(vinyl chloride) fiber, modification of polyester fiber by grafting, and modification of polyester and cotton-blend fabric are discussed. (auth)

44385 NMR STUDY OF THE SOLID-STATE POLYMERIZATION OF γ-IRRADIATED VINYL MONOMERS. I. INTRODUCTION. Chachaty, C. (CEN de Saclay, Gif-sur-Yvette, France); Forchioni, A.; Ban, Buu. J. Polym. Sci., Part B; 9: No. 7, 483-90(Jul 1971).

NMR studies were made on γ-induced polymerization of solid vinyl monomers and these experiments were completed by ESR measurements of the concentration of radicals under the same conditions of irradiation and warming of samples. Data are given for acrylamide and acrylic acid. (M.C.G.)

44386 POST-CROSSLINKING OF FORMED POLYMERS BY IRRADIATION. 1. THE POST-CROSSLINKING OF POLY (VINYL ACETATE) FORMED MATERIALS WITH DIVINYL-BENZENE–CYCLOHEXANE–BENZENE SOLUTION BY IRRADIATION. Ito, Syoji; Ohnishi, Shunji; Aoki, Masakatsu (Research Inst. for Polymers and Textiles, Yokohama, Japan). Seni Kobunshi Zairyo Kenkyusho Kenkyu Hokoku; No. 90, 11-17(Mar 1970). (In Japanese).

Poly(vinyl acetate) formed materials are soluble in many organic solvents such as acetone, benzene, and methanol, and in most polyfunctional monomers. In order to crosslink formed polymers, it is necessary to irradiate either while swelled with crosslinking reagents or molded after blending the reagent. The use of polyfunctional monomers sensitizes the crosslinking. It is apparent that there is a limitation for the usage of polyfunctional monomers because of solubility of the monomers and of the difficulty in keeping the shape of materials. The post-crosslinking of poly(vinyl acetate) films by irradiation was carried out. Poly(vinyl acetate) films were soaked in mixed solutions of cyclohexane, benzene, and divinylbenzene in a glass tube. By controlling the monomer concentration, the polymers were kept insoluble in the mixed solution. Cyclohexane was used as a shape-keeping reagent and a solvent for divinylbenzene. The films absorb the mixed solution. After γ irradiation, crosslinked films showed no shrinkage and swelling. (auth) (Japan)

44387 POST-CROSSLINKING OF FORMED POLYMERS BY IRRADIATION. 2. THE POST-CROSSLINKING OF POLYSTYRENE-FORMED MATERIALS WITH ISOPRENE BY IRRADIATION. Ito, Syoji; Ohnishi, Shunji (Research Inst. for Polymers and Textiles, Yokohama, Japan). Seni Kobunshi Zairyo Kenkyusho Kenkyu Hokoku; No. 90, 18-22(Mar 1970). (In Japanese).

The radioinduced crosslinking of formed polystyrene with polyfunctional monomers was studied. Polystyrene formed polymers are soluble in many organic solvents such as benzene, toluene and xylene. It is impossible to use adhesives containing such organic solvents with these materials. Therefore, the post crosslinking of polystyrene films by irradiation was carried out. Polystyrene films were soaked in a mixed solution of methanol and a diene monomer, 2-methyl-1,3-butanedione, in a glass tube. By controlling the monomer concentration, the polymers were kept insoluble in mixed solution. Methanol was used as a shape-keeping reagent and a solvent for the diene monomer. After γ irradiation the crosslinked films showed no shrinkage and swelling. (auth) (Japan)

44388 RADIATION-INDUCED ISOMERIZATION OF THE 1,2-DIPHENYLPROPENES IN POLAR LIQUIDS. Hentz, Robert R.; Altmiller, H. G. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 75: No. 15, 2394-9(22 Jul 1971).

Radioinduced cis-trans isomerizations of the 1,2-diphenylpropenes were studied in acetone, ethanol, diethyl ether, and 1,2-dimethoxyethane. Singlet excitation transfer between acetone and trans-1,2-diphenylpropene was not detectable in a study of acetone fluorescence from solutions excited at 3130 Å. Consequently, results for the photosensitized isomerization are attributed to transfer of triplet excitation from acetone. Such results give $\chi = 1.0 \pm 0.1$ for the efficiency of intersystem crossing from the lowest excited singlet of liquid acetone and $k\tau = 9 \times 10^2 M^{-1}$ as the product of the specific rate of excitation transfer and lifetime for the lowest triplet of liquid acetone. Results for γ-irradiated solutions of the 1,2-diphenylpropenes in acetone indicate that solute excitation, with subsequent isomerization, occurs entirely by transfer of triplet excitation from acetone to solute at concentrations below about 0.01 M. Such results give $k\tau = 9 \times 10^2\ M^{-1}$, in agreement with the photosensitization results, and a yield of lowest triplets of acetone of $^3G = 1.5$, which agrees well with values determined in pulse-radiolysis studies. Isomerization yields in ethanol and the two ethers are lower than those in acetone and decrease in the order 1,2-dimethoxyethane, diethyl ether, and ethanol. It is suggested tentatively that solute excitation in the two ethers occurs, as previously proposed for cyclohexane solutions, in charge-neutralization reactions in which solute ions (formed by electron and positive-hole capture) are involved. The low isomerization yields obtained in ethanol and the two ethers and the variation in yield with solvent are ascribed to the occurrence with varying degrees of rapidity of the proton-transfer reaction (which precludes solute excitation) between a solvent cation and solvent molecule. (auth)

44389 PROCESS FOR IRRADIATING POLYVINYLIDENE FLUORIDE AND A COMPATIBLE POLYFUNCTIONAL MONOMER AND PRODUCT THEREOF. Lanza, Vincent L. (to Raychem Corp.). U. S. Patent 3,580,829. 25 May 1971. Filed 1 Mar 1968.

A composition comprising poly(vinylidene fluoride) and a compatible polyfunctional monomer may be treated with low doses of irradiation to provide a crosslinked poly(vinylidene fluoride) having excellent strength properties, resistance to heat aging, and the property of elastic memory. (Offic. Gaz.)

Radiolysis

Refer also to abstracts 44772 and 44777.

44390 (KFKI–71-21) KINETICS OF OH RADICAL REACTIONS IN IRRADIATED ORDINARY AND SUPERCOOLED WATER. Kules, Inna; Schiller, Robert (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1971. 10p. (CONF-710517–1). Dep. NTIS (U. S. Sales Only).

From third symposium on radiation chemistry; Tihany, Hungary (10 May 1971).

Studies were made of the kinetic nature of OH radical reactions including temperature-dependent kinetics of competing OH scavenger reactions and diffusion-controlled processes. Investigations were also made on whether supercooling had any effect, besides that of the change in temperature, on reaction kinetics. Irradiations were carried out using a ^{60}Co γ source. Results indicated that supercooling did not exert any particular effect on competition kinetics. All the OH radical reactions were diffusion-controlled and obeyed the Noyes equation. (M.C.G.)

44391 ACTION OF GAMMA RADIATION ON PURINE OLIGONUCLEOTIDES OF COTTON SEED DNA. Aripdzhanov, Sh. A. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 1, 58-9 (1971). (In Russian).

Cotton seeds were irradiated by a ^{60}Co γ source at a dose rate of 13 R/sec to total doses of 1, 6, and 25 kR. DNA was isolated by a hydrolysis procedure from a 2-day germination. It was found that depolymerization had occurred as a result of the radiation, with the formation of mono-, di-, and trinucleotides and a decrease of tetra-, penta-, and hexanucleotides. (K.S.W.)

44392 EFFECT OF DOSE RATE OF GAMMA RADIATION ON VITAMIN E RADIOLYSIS IN VEGETABLE OILS. Uralova, M. (Research Inst. of Hygiene, Bratislava). Prum. Potravin; 20: No. 11, 336-7(Oct 1969). (In Slovak).

The radiolysis of vitamin E in vegetable oils was studied in relation to the dose and dose rate of ^{60}Co γ radiation. After exposure, α-tocopherol was extracted from the irradiated oil and determined by the colorimetric method. The following amounts of vitamin E in proportion to the amount originally present were found in soya oil after irradiation with 10^4, 2×10^4, 4×10^4, and 8×10^4 rad (for each dose three values are given corresponding to dose rates of 9,800, 85,000, and 500,000 rad/hr, respectively): 79, 91, 99; 45, 82, 95; 50, 70, 75; 35, 52, 61%. With sunflower oil the values were as follows: 92, 100, 100; 82, 87, 100; 68, 66, 91; 52, 60, 75%. For maize oil the following results were obtained: 77, 96, 100; 63, 80, 94; 55, 72, 85; 52, 70, 80%. (NSA of Czech)

44393 EFFECT OF IONIZING RADIATION ON SOYBEAN PROTEIN. 1. EFFECT OF CATHODE RAY RADIATION ON FROZEN DENATURATION. Hashizume, Kazumoto; Umeda, Keiji; Watanabe, Tokuji (Food Research Inst., Tokyo). Nippon Shokuhin Kogyo Gakkaishi; 18: No. 2, 80-3(Feb 1971). (In Japanese).

Soybean protein solutions were irradiated with the doses of 0.1, 0.5, and 2.5Mrad of cathode-ray electrons to investigate the effect of irradiation on the properties of soybean protein, such as content of free SH groups, disc electrophoretic pattern, and solubility behavior in freezing and thawing. Free SH groups of the protein increased by the irradiation with 0.5Mrad and their content was 7×10^{-5}M/10g protein by the dose of 2.5Mrad. The irradiated protein in the solution, in which free SH groups increased, became more insoluble by freezing and thawing than untreated protein. Disc electrophoretic pattern of the 11S component irradiated with a dose of 0.5Mrad showed a change with an increase of slow-moving components, but no change was observed by irradiation

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in the presence of mercaptoethanol. The insolubilization of the irradiated protein in the solution by freezing and thawing might be promoted by the increase of active groups such as SH groups brought by conformational changes of the protein molecule with irradiation. (auth) (Japan)

44394 EFFECTS OF DIPOLAR APROTIC SOLVENTS ON THE STABILITY OF FREE RADICALS IN γ-IRRADIATED COTTON CELLULOSE. Reine, Alden H.; Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part B; 9: No. 7, 503-7(Jul 1971).

The effects of the dipolar aprotic solvents on scavenging of cellulosic free radicals in irradiated cotton are probably related to the ability of these solvents to penetrate and swell cotton. About 20% of the initially formed free radicals were not terminated even after immersion in methyl sulfoxide or water for 120 min at 25°C. This value was about 35% for dimethylformamide. Temperature increases caused increases in the rate and extent of interaction of dimethylformamide and methyl sulfoxide with irradiated cellulose. (M.C.G.)

44395 GAMMA RADIOLYSIS OF n-HEXADECANE OCCLUDED IN THE CRYSTAL LATTICE OF SYNTHETIC ZEOLITES. Faucitano, A.; Allara, G. (Univ., Pavia, Italy). Chim. Ind. (Milan); 53: No. 3, 254-8(Mar 1971). (In Italian).

Radiolytic yields of the straight-chain saturated hydrocarbons from C_1 to C_{14}, and of ethylene, propene, and butene were measured during radiolysis of n-hexadecane adsorbed in a molecular sieve and in the liquid state. A comparison of the two systems shows that the zeolite influences the mechanism of the radiolysis, the kinetics, the yield, and the distribution of the products. The zeolite apparently exercises two distinct effects that increase the decomposition velocity of the hexadecane: (1) radiation may create active centers in the zeolite and thereby aid in transference of energy to the hydrocarbon, and (2) another type of catalyst is probably negligible at 35°, but acquires importance with increase of temperature. At 200° the decomposition of hexadecane in the liquid phase proceeds instead with a chain mechanism. During radiolysis in the liquid phase at 35°C the product distribution is rather symmetrical, but at 200° it has become asymmetrical because of a gain in the relative yield of the light hydrocarbons. In the case of radiolysis in the absorbed state, the distribution curves remain symmetrical. The yields of ethylene, propene, and butene are clearly smaller in radiolysis in the adsorbed state, possibly because the olefins participate in secondary reactions that may be promoted by the radiation-induced catalytic centers of the zeolite. (tr-auth)

44396 DEUTERIUM ISOTOPE EFFECT ON THE DECAY KINETICS OF PERHYDROXYL RADICAL. Bielski, Benon H. J. (Brookhaven National Lab., Upton, N. Y.); Saito, Eiichi. J. Phys. Chem.; 75: No. 15, 2263-6(22 Jul 1971).

Rate constants for the disproportionation of HO_2 in H_2O and DO_2 in D_2O were determined as a function of acidity and temperature. The radicals were generated by pulse radiolysis and by oxidation of peroxide with ceric sulfate. It was found that the isotope effect on the decay rates of the two radicals varies with pH. The pK values for HO_2 and DO_2 were 4.8 and 4.9, respectively. Activation energies for the decay in 0.8 N H_2SO_4 and 0.8 N D_2SO_4 were 5.8 kcal/mole for HO_2 and 7.3 kcal/mole for D_2O. (auth)

44397 PULSE RADIOLYSIS OF LIQUID AMIDES. Hayashi, N.; Hayon, E.; Ibata, T.; Lichtin, N. N.; Matsumoto, A. (Boston Univ. Army Natick Labs., Natick, Mass.). J. Phys. Chem.; 75: No. 15, 2267-72(22 Jul 1971).

The pulse radiolysis of the following liquid amides was investigated: formamide (F), N-methylformamide (NMF), N,N-dimethylformamide (DMF), N,N-dimethylacetamide (DMA), and N-methylpropionamide (NMP). Radioinduced ionization and excitation processes were observed on irradiation of solutions of anthracene (A) and naphthalene (N), as indicated by the characteristic spectra of A^-, N^-, A^T, and N^T. The yields of these species were determined, based on known extinction coefficients. Transient absorptions with $\lambda_{max} \sim 650$ and 625 nm in DMF and DMA, respectively, were assigned to the absorption spectra of solvated electrons in these liquid amides. Absorption bands at $\lambda_{max} \sim 350$ nm due to the radicals $HCONH(\dot{C}H_2)$, $HCON(\dot{C}H_2)(CH_3)$, and $CH_3CON(\dot{C}H_2)(CH_3)$ were observed and characterized. The nature of some of the other transient absorptions produced is discussed. It was concluded that the absorption with λ_{max} at 540 nm which is produced in F is, contrary to a previous assignment, not due to solvated electrons. (auth)

44398 EFFECT OF POSITIVE ION SCAVENGING BY BENZENE IN THE RADIOLYSIS OF PROPANE. Wei, Lester Y.; Bone, Larry I. (East Texas State Univ., Commerce). J. Phys. Chem.; 75: No. 15, 2272-6(22 Jul 1971).

Propane was irradiated in the presence of small quantities of benzene at various total doses. It was deduced that propyl ions react readily with benzene and the final stable molecular products are cumene and diphenylpropane. Ethyl ions react with benzene approximately four times faster than they react with propane. In the presence of 1 mole % benzene the yields of all stable hydrocarbon products are independent of total dose. From this information it was deduced that in the gas-phase radiolysis of pure propane, the observed conversion dependence must result from ion interception by accumulated unsaturates. (auth)

44399 ELECTRON SPIN RESONANCE STUDY OF RADICALS PRODUCED IN IRRADIATED AQUEOUS SOLUTIONS OF THIOLS. Neta, P.; Fessenden, Richard W. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 75: No. 15, 2277-83(22 Jul 1971).

Radicals produced by reaction of hydrated electrons and hydroxyl radicals with several organic thiols in aqueous solutions were studied by electron spin resonance. Irradiation with high-energy electrons was carried out directly in the ESR cavity. Spectra of the radicals $\dot{C}H_2COO^-$ and $^-S\dot{C}HCOO^-$ (g = 2.0086, a^H_{CH} = 13.4 G) were obtained from alkaline solutions of mercaptoacetate. The variation in intensity of the two spectra when various scavengers were added shows that the two species were formed by reactions of e^-_{aq} and OH, respectively. The radical SCH_2COO^- is also expected to be formed by reaction of OH but could not be observed under our experimental conditions. Similarly, the radicals $^-OOCCH_2\dot{C}HCOO^-$ (g = 2.0033, a^H_{CH} = 20.4 G, $a^H_{CH_2}$ = 23.6 G) and $^-OOCCH_2\dot{C}(S^-)COO^-$ (g = 2.0075, a^H_{CH} = 8.7 G) in solutions of mercaptosuccinate were found to result from the reaction of e^-_{aq} and OH, respectively. Substituted alkyl radicals produced by hydrogen abstraction from 3-mercaptopropionate, cysteine, thiodiglycolic acid, and dithiodiglycolic acid were also observed. (auth)

44400 LOW-ENERGY ELECTRON RADIOLYSIS OF METHANE. Finney, C. D.; Moser, H. C. (Kansas State Univ., Manhattan). J. Phys. Chem.; 75: No. 15, 2405-7(22 Jul 1971).

Some results pertaining to product thresholds from low-energy electron radiolysis of methane differ from those previously reported. Photoelectrons were used in the tetrode radiolysis cell. The experimental threshold for ion formation occurred in the region of an applied potential of 20V. The formation of significant yields of C_2H_6 and C_2H_4 at applied potentials where no ions were detected is evidence for primary excitation being a principal contributor to these yields. (M.C.G.)

Radioisotope Production

Refer also to abstracts 44410 and 45998.

44401 (BMBW-FBK-70-28, pp 146-57) TARGET CHEMISTRY AT ISOLDE. Hageboe, E. (Oslo Univ. (Norway). Dept. of Chemistry).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Thick-target chemistry associated with ISOLDE is reviewed. Radiation chemistry of the hardware, chemical properties of products, separation of products from target material, chemical product separations on-line, and ion source chemistry are discussed. (M.C.G.)

44402 (BMBW-FBK-70-28, pp 158-67) HYDROXIDES OF TITANIUM, ZIRCONIUM, CERIUM(IV), AND THORIUM FOR THE ON-LINE PRODUCTION OF NOBLE GASES AT THE ISOLDE FACILITY. Patzelt, P. (European Organization for Nuclear Research, Geneva (Switzerland)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Target preparation, target properties, and on-line performance of partially dehydrated hydroxides of titanium, zirconium, cerium(IV), and thorium are reviewed. Cumulative yield distributions of krypton, xenon, and radon isotopes from the 600-keV proton spallation of zirconium, cerium, and thorium, respectively, are discussed. (auth)

44403 (ORNL-4666) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING DECEMBER 31, 1970. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 33p. Dep. NTIS.

During the period July 1, 1970, through December 31, 1970,

80.8 g of ^{244}Cm, 10.5 mg of ^{249}Bk, 76 mg of ^{252}Cf, 312 μg of ^{253}Es, and 10^9 atoms of ^{257}Fm were recovered as purified products from 35 reactor slugs that were irradiated as part of the Californium-I program at the Savannah River Plant. Fifty-five shipments were made, which contained the following total amounts of nuclides: 0.5 mg of ^{244}Pu isotopically enriched in a calutron and then irradiated in the HFIR prior to shipment; 0.26 g of ^{243}Am; 29 g of ^{244}Cm; 1 mg of ^{248}Cm; 851 μg of ^{249}Bk; 425 μg of isotopically pure ^{249}Cf; 23.1 mg of ^{252}Cf in a mixture of californium isotopes; 240 μg of ^{253}Es; and 9×10^8 atoms of ^{257}Fm. Analysis of the future rate of production of ^{252}Cf at TRU indicates that about 0.5 g per year can be produced by irradiating curium containing 95% ^{244}Cm, or about 1.2 g per year by irradiating curium recovered from the SRP Californium-I campaigns (which contains about 24% ^{246}Cm). The processes and equipment used for the SRP reactor slugs were generally the same as those used to process HFIR targets. A large iodine removal unit consisting of a catalytic oxidation bed to destroy organic vapors, followed by charcoal beds for adsorbing iodine, was installed for treating the entire vessel and cubicle off-gas system (450 cfm). During the campaign to process the 35 slugs, which contained 400 Ci of ^{131}I, about 400 mCi of the iodine was volatilized and reached the system. The average rate of release of ^{131}I was less than 6 μCi per day; system DF's were greater than 700. Eight neutron sources were fabricated. The values currently being used for transuranium-element decay data and for cross-section data in planning irradiation-processing cycles, calculating production forecasts, and assaying products are tabulated in the Appendix. (auth)

Recoil Production and Reactions

44404 (BMBW-FBK-70-28, pp 168-74) USE OF CHEMICAL REACTIONS OF RECOIL ATOMS FOR ON LINE SEPARATIONS. Wolf, G. K.; Fritsch, T. (Heidelberg Univ. (West Germany). Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The efficiency, selectivity, and speed of the evaporation of oxide compounds from heterogeneous targets were investigated. Preliminary experiments on the behavior of these compounds in the ion source of an electromagnetic separator were performed. (M.C.G.)

44405 REACTIONS OF RECOIL CARBON ATOMS WITH OXYGEN-CONTAINING MOLECULES. II. STRUCTURAL DEPENDENCE OF CARBON MONOXIDE YIELDS. Voigt, A. F.; Palino, G. F.; Williams, R. L. (Ames Lab., Iowa). J. Phys. Chem.; 75: No. 15, 2248-52(22 Jul 1971).

Carbon-11 was produced by the reaction $^{12}C(\gamma,n)^{11}C$ in liquid alcohols and ethers, and the yield of ^{11}CO was determined by radiogas chromatography. The carbon monoxide yield is correlated with molecular structure by a simple bond and site counting model. Correlations are also shown between the yields and the Taft σ^* parameter derived for inductive effects in aliphatic systems. Implications of the site model and the inductive effects of carbon-chain branching on the yields are discussed. (auth)

44406 REACTIONS OF RECOIL CARBON ATOMS WITH OXYGEN-CONTAINING MOLECULES. III. REACTION MECHANISMS IN METHANOL. Williams, R. L.; Voigt, A. F. (Ames Lab., Iowa). J. Phys. Chem.; 75: No. 15, 2253-8(22 Jul 1971).

Carbon-11 was produced by the reaction $^{12}C(\gamma,n)^{11}C$ in liquid methanol, and the yields of labeled products were determined by radiogas chromatography. Reaction alternatives for the intermediate resulting from carbon atom insertion into a C–H bond of methanol are discussed. The dependence of the yields of carbon monoxide and acetaldehyde on the duration of the irradiation period is attributed to reactions of the solvated electron; kinetic expressions are developed. (auth)

Radiochemistry

Refer also to abstract 44441.

44407 COMBUSTION APPARATUS, PARTICULARLY FOR PREPARATION OF SAMPLES FOR RADIOACTIVE ISOTOPE TRACER STUDIES. Kaartinen, N. H. Canadian Patent 870,939. 18 May 1971. Priority date 16 May 1967, Finland.

A method and an apparatus are described for the processing of fluid materials, particularly in the preparation of samples for radioactive isotope tracer studies by combustion of starting materials containing such isotope tracers. The sample is burned in a combustion chamber, which tapers upwardly and inwardly above the sample receptacle so as to approximate the shape of the flame of the burning sample. The combustion products are continually exhausted from the combustion chamber and passed through a heat exchanger, which condenses the vapors. Oxygen is fed into the combustion chamber at a controlled rate during combustion. Afterward, nitrogen gas is fed into the combustion chamber and exhausted through a heat exchanger so as to purge the system of any remaining gaseous products. (F.S.A.) (Canada)

Separation Processes

Refer also to abstracts 44401, 44402, 44404, 44501, 46145, and 46276.

44408 (ANL-Trans-885) SGCR-GC CENTRIFUGAL EXTRACTOR TESTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 7.8, pp 241-54 of report CEA-N-1241. 11p. Dep. NTIS.

An abstract of this section, prepared from the original language, appeared as a part of NSA 24: 36339. (J.G.B.)

44409 (ANL-Trans-887) TREATMENT OF URANIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 3, pp 112-21 of report CEA-N-1341. 10p. Dep. NTIS.

An abstract of this section, prepared from the original language, appeared as a part of NSA 25: 6392. (J.G.B.)

44410 (BMBW-FBK-70-28, pp 126-45) CHEMICAL PROBLEMS OF THE ON-LINE SEPARATION OF SHORT-LIVED NUCLIDES. Baechmann, K. (Technische Hochschule, Darmstadt (West Germany). Eduard-Zintl-Institut).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An on-line investigation of a single short-lived nuclide requires a separation of different elements and different masses. A separation of different elements is achieved by means of chemical procedures whereas a mass-separator separates out different masses. The use of "thick" targets leads to a first elimination of elements due to the formation of volatile compounds and different diffusion velocities. A "thin" target makes it necessary to stop the recoils either in an inert gas (helium-jet) or in a reactive gas (which forms a volatile compound) or finally in a solid catcher. Another separation is possible between target and ion source using condensation, adsorption, or chemisorption. A very fast technique is a combination of target and ion source. A final chemical step may be carried out at the collector of a mass-separator. Some possible arrangements for the investigation of short-lived nuclides are discussed. (auth)

44411 (BNWL-1584) PLATINUM-CATALYZED HYDRAZINE REDUCTIONS OF PLUTONIUM(IV) AND URANIUM(VI). Swanson, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1971. Contract AT(45-1)-1830. 25p. Dep. NTIS.

Platinum-catalyzed hydrazine reductions of plutonium(IV) and uranium(VI) were studied for possible application in the separation of plutonium from uranium in the Purex solvent extraction process. Reaction rates, reaction stoichiometry, catalyst stability, and catalyst poisoning were studied. An unidentified catalyst poison was found to be present in the uranium product stream of the Hanford Purex plant. (auth)

44412 (DOCKET-50201-81) WEST VALLEY REPROCESSING PLANT. Quarterly Report, April 1–June 30, 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 29 Jul 1971. 7p. Dep. NTIS.

Data are reported on: environmental monitoring, low-level liquid effluents, stack effluents, and surveillance tests. (M.C.G.)

44413 (DOCKET-50268-13) MIDWEST FUEL RECOVERY PLANT. Preliminary Safety Analysis Report, Amendment 15 (Includes Additional Information Supporting Conversion of Construction Permit into an Operating License). (General Electric Co., San Jose, Calif. Nuclear Energy Div.). 20 Jul 1971. 109p. Dep. NTIS.

Information is presented in support of the application for conversion of the construction permit into an operating license. Sub-

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surface water conditions for the site were determined, and monitoring and control effort were expanded. The potential effect on plant operations was evaluated, and it was concluded that radioactive material control objectives can be met in the as-built plant. Information is presented on the activities that require receipt, possession, processing, use, and transfer of source, special nuclear, and byproduct materials and a request for their authorization. Response to twenty AEC staff questions of May 28, 1971 and errata and addenda consisting of a table of process equipment fission product inventory are given. (M.C.G.)

44414 (IN–1472) RUN REPORT FOR THE FIRST CAMPAIGN OF CO-PROCESSING ALUMINUM AND ZIRCONIUM FUELS AT ICPP. Offutt, G. F.; Cole, H. S. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 16p. Dep. NTIS.

During the first co-processing campaign at the Idaho Chemical Processing Plant (ICPP) aluminum and zirconium fuels containing highly enriched uranium were dissolved in separate dissolvers and the dissolver products blended together to form feed for the solvent extraction system. Considerable savings were realized over what the cost would have been had they been processed separately. (auth)

44415 (NYO–844–84, pp 21–5) NEODYMIUM–SAMARIUM SEPARATIONS FOR GEOCHRONOLOGICAL APPLICATIONS. Karol, Paul J. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

A precise method was developed for reproducible separations of adjacent rare earths, based on lanthanide separation by cation-exchange column chromatography using α-hydroxyisobutyric acid. (M.C.G.)

44416 (UCRL–73190) HIGH-SPEED SEPARATION OF THE RARE EARTHS BY ION EXCHANGE CHROMATOGRAPHY. Sisson, D. H.; Mode, V. Alan (California Univ., Livermore. Lawrence Radiation Lab.). 10 May 1971. 10p. (CONF-710711–1). Dep. NTIS.

From fourth conference on liquid chromatography; Los Angeles, Calif. (8 Jul 1971).

Studies were made of high-pressure liquid chromatographic techniques of 2 to 300 psi pressure, particle diameter of 5 to 50μ, and linear flow of 10 to 14 cm/min, which would allow complete rare earth separation in 3 to 4 hours. The solvent gradient proved to be the primary experimental parameter. The gradient had a fairly small effect on the heavy rare earths and a much larger effect on the light rare earths. The X12 resin gave generally better resolution than the X4 one and 25- to 35-μ particles gave significantly better resolution than 40- to 50-μ particles. A slight loss in resolution was observed at the highest flow rate. The 2.0 to 2.5 and 110 to 150 psi flow rates gave similar resolution. (M.C.G.)

44417 (UR–3999–10) FUNDAMENTAL STUDIES IN ISOTOPE CHEMISTRY. Progress Report, July 1, 1970–June 30, 1971. Bigeleisen, Jacob (Rochester Univ., N. Y.). Contract AT(30-1)-3999. 57p. Dep. NTIS.

Research progress is reported on vapor pressures of the krypton isotopes, fractionation factors for the argon isotopes between the triple and critical points, and correlation of isotope effects with molecular forces. (M.C.G.)

44418 IMPROVEMENTS IN ZIRCONIUM AND HAFNIUM PURIFICATION METHODS. Saint-James, Rose; Hure, Jacques (to Commissariat a l'Energie Atomique). German Patent 1,300,532. 7 Aug 1969. Priority date 17 Mar 1954, France. (In German).

Processes and installations for preparing and purifying zirconium and hafnium were improved. These improvements make use chiefly of the separation of zirconium and hafnium between two solvents or immiscible phases. One phase consists of zirconium and hafnium in acidic aqueous solution and the other phase consists of acidified or neutral solvent. (M.C.G.)

44419 PURIFICATION OF IODINE BY FILTRATION OF ITS MELTS. Kirgintsev, A. N.; Kabysheva, V. I.; Sokolov, V. M. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 1, 9-12(Jan 1971).

Translated from Zh. Prikl. Khim.; 44: No. 1, 11-14(Jan 1971).

The use of filtration for purification of crude iodine melts was investigated. "Pure" grade iodine (99.5% iodine) could be obtained by filtration through Nos. 3 and 4 filters. Filtration preceded by distillation of volatile impurities gave almost the same results. Iodine samples fused under sulfuric acid and filtered through a No. 2 filter contained 99.8% iodine (analytical grade). (M.C.G.)

44420 RECOVERY OF USEFUL RADIOISOTOPES FROM REPROCESSING WASTES AND THEIR APPLICATION. Ishihara, Takehiko (Japan Atomic Energy Research Inst., Tokai); Amano, Hiroshi; Nakamura, Haruto; Kitani, Susumu; Segawa, Takeshi. Nippon Genshiryoku Gakkaishi; 12: No. 10, 597-610(Oct 1970). (In Japanese).

Reprocessed wastes are useful sources of radioisotopes because they contain high-level radioactive substances. Recovery of the radioisotopes from fission products is important, because it is helpful for the economics of fuel reprocessing. Separation of the fission products is carried out by ion exchange, solvent extraction, adsorption, absorption, etc. Development of useful applications has been carried out. A radioisotope power generator is illustrated as an example. (Japan)

44421 CATION EXCHANGE STUDIES ON AMMONIUM-12-MOLYBDOPHOSPHATE. II. BIVALENT IONS. Coetzee, C. J. (Univ. of Western Cape, Bellville, S. Afr.); Van Wyk, A. J. J. Inorg. Nucl. Chem.; 33: 1501-8(May 1971).

The exchange capacity of ammonium-12-molybdophosphate for the divalent ions Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}, and Hg^{2+} was determined by column chromatography. The maximum exchange was not stoichiometric. Equilibrium studies were made as a function of ammonium concentration and pH. The experimental results suggested that the exchanged species might be monovalent. (auth) (UK)

44422 SOME RESULTS OF LIXIVIATION TESTS ON BULK URANIFEROUS QUARTZITE ORE UNDER FIELD CONDITIONS AT CHHINJRA, KULU DISTRICT, HIMACHAL PRADESH. Jayaram, K. M. V.; Kulshrestha, S. C. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 5, 291-7(Sep 1970). (CONF-681088–2).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

Uraninite occurs as veins in a hard, compact quartzite at Chhinjra in the Middle Himalayas. Two tests on bulk ore were carried out at site under field conditions, after a study of suitable parameters in the laboratory, to extract uranium cheaply by lixiviation methods. The first difficulty that had to be overcome was to reduce grinding of the ore to the barest minimum, a contingency that does not arise in the case of pervious sandstone-type deposits. The other parameters involved in the study were pH and redox potential levels required to be maintained during leaching, control of iron present, which affects oxidation of tetravalent uranium to the soluble hexavalent state, and peptization problems in precipitation of uranium from pregnant liquor. The parameters found suitable in the laboratory yielded better results in bulk treatment of ore in the field. In the field test No. 2, at a feed size of –10 mesh, with 70 lb/ton of 1% H_2SO_4 and 10 lb/ton MnO_2, a leachability of 83.3% was obtained, from ore analyzing 0.06% U_3O_8, against 67.9% leachability obtained in the laboratory tests with 60 lb/ton of 1% H_2SO_4 and 10 lb/ton of MnO_2 on an ore analyzing 0.10% U_3O_8. Although good results emerged, investigations are now being carried out to reduce acid and oxidant consumption, by controlling ferrous/ferric ratios, and peptization losses. (auth)

44423 STUDIES IN THE BENEFICIATION OF URANIUM MINERALS FROM NARWAPAHAR–SINGHBHUM. Ghosh, C.; Narasimham, J. B.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 5, 285-90(Sep 1970). (CONF-681088–1).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

The low-grade uranium deposit in Narwapahar in the Singhbhum Thrust Zone is composed of: quartz, 51.0%; chlorite, 38.0%; apatite, 4.8%; magnetite, 4.3%; sulphides, 0.2%; and U_3O_8, 0.055%. The principal uranium mineral is uraninite, which is liberated mostly at about 270 mesh. The ore was wet ground (85%−200 mesh) and then hydraulically classified to three fractions, and the different fractions were wet tabled. The tailings of all the fractions were retabled. The retabled tailings of the coarsest fraction were reground and tabled. The combined concentrate (45.8%) assayed 0.1% U_3O_8 eq., the recovery being 86.6%. (auth)

44424 LEACHING AND PRECIPITATION OF URANIUM FROM QUARTZITE ORES AT CHHINJRA, KULU DISTRICT, HIMACHAL PRADESH. Jayaram, K. M. V.; Deshpande, A. S.; Sharma, C. V. (Dept of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 5, 298-305(Sep 1970). (CONF-681088–3).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

The lixiviation of uranium ore occurring in a quartzite at

Chhinjra presented certain problems from the grinding stage to the final precipitation of uranium as crude cake at site as cheaply as possible without use of conventional plant. Experiments were carried out to find suitable parameters for feed size, pH, redox potential, etc. It was found that 10 mesh (ASTM) feed size was a median between too coarse a size, which reduced recovery, and too fine a size, which resulted in compaction of ore and prevented acid percolation. Leaching efficiency, which depends largely on the oxidation of uranium to a higher valence state, increased with the use of MnO_2, or $HClO_4$, but there were significant losses in the precipitate due to occlusion of uranium with ferric ion. Reduction of the ferric to ferrous ion, which thus became necessary, was effected by addition of scrap iron or zinc to the pregnant liquor before precipitation, which resulted in an increase in precipitation of uranium. The effects of oxidation on leaching and precipitation of uranium are discussed. (auth)

44425 EXTRACTION AND UTILIZATION OF PURE NIOBIUM AND TANTALUM FROM INDIAN ORES. Damodaran, A. D.; Deshpande, S. G.; Majmudar, A. A.; (and others) (Bhabha Atomic Research Centre, Trombay, India). Proc. Indian Nat. Sci. Acad., Part A; 36: No. 5, 306-18(Sep 1970). (CONF-681088-4).

From Symposium on the geology and mineralogy of atomic mineral deposits and their development for use in the nuclear power program; New Delhi, India (14 Oct 1968).

A process was developed for the chemical treatment of Indian columbite-tantalite minerals for recovery of values and the separation and purification of niobium and tantalum compounds by solvent extraction and for extraction of the pure metals from the intermediates and their further purification and consolidation by electron beam melting and high-vacuum sintering. The progress made to date and the production program visualized are summarized. (M.C.G.)

44426 SEPARATION PROCESSES FOR NOBLE GAS FISSION PRODUCTS FROM THE OFF-GAS OF FUEL-REPROCESSING PLANTS. Slansky, Cyril M. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 9: No. 2, 423-40(Jun 1971).

Processes have been developed for the removal and storage of radioactive noble gases from process streams of the fuel reprocessing industry and from gases resulting from a potential fuel melt-down. The separation processes described for noble gases in air include room-temperature adsorption on charcoal, low-temperature adsorption on charcoal, cryogenic distillation, preferential absorption by liquids, rare-gas clathrates, kryptonates, fluorine reaction, thermal diffusion, electrostatic diffusion, and diffusion through a perm-selective membrane. Several of these processes have been proven on a semi-plant scale. Advantages and disadvantages are listed for the processes, although all processes have not reached the same degree of development. It is concluded that processes exist which have been demonstrated satisfactorily on an engineering scale for the removal of up to 98% of the noble gases from reprocessing plant dissolver off-gas. The cost of such treatment should not increase significantly the cost of nuclear power. (65 references) (auth)

44427 TECHNIQUES FOR SEPARATING AMERICIUM FROM URINE AFTER DTPA THERAPY. Horm, Imogene F. (Univ. of Pittsburgh). Health Phys.; 21: No. 1, 41-6(Jul 1971).

A method is described for the analysis of different chemical forms of the same isotope excreted in the urine of a human receiving DTPA (diethylenetriaminepentaacetic acid, tri-sodium, calcium salt). While DTPA–bound americium was present in urine, another fraction whose excretion rate was independent of injection of the chelating agent could be isolated. Solvent extraction of acidified urine with bis(2-ethyl hexyl) hydrogen phosphate (HDEHP) removed this "unchelated" americium from the aqueous phase although it did not interact with the DTPA bound species. After the urine was ashed, reextraction with HDEHP recovered the remaining activity from the ash. This method was developed because it was rapid and needed simple equipment. The principal advantage of the method, however, was that it measured directly the effectiveness of chelation treatment for the removal of hazardous nuclides. When the gel filtration technique was used to determine the molecular weight distribution of americium in the patient urine, results strongly suggested the presence of two separate compounds. Unfortunately, the molecular weights did not differ by a large amount, and a complete separation of peaks was impossible. However, this data combined with solvent extraction results indicated that americium exists in more than one chemical form in the urine of an individual receiving periodic DTPA treatments for removal of systemically distributed ^{241}Am. (auth) (UK)

44428 FUEL REPROCESSING IN ITALY. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 89-91(Oct 1970). (In Italian). (CONF-700903-12).

From fourth Foratom congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden (21 Sep 1970).

Italy has two pilot plants for fuel reprocessing, the EUREX and the ITREC plants. The present and future demands for reprocessing are evaluated. The treatment and classification of the wastes is briefly considered. (J.S.R.)

44429 SOLVENT EXTRACTION OF ZIRCONIUM AND HAFNIUM. I. EXTRACTION WITH DI-n-BUTYLMETHYLENEBISPHOSPHONIC ACID. Meider-Gorican, H. (Ruder Boskovic Inst., Zagreb). J. Inorg. Nucl. Chem.; 33: No. 6, 1919-26(Jun 1971).

The extraction of zirconium and hafnium from sulphuric, hydrochloric, and perchloric acids and fluoride solutions with di-n-butylmethylenebisphosphonic acid (DBMPA) was studied. The ligand/metal ratios were determined by slope analysis, and the dependence of extraction on sulphate and fluoride ion concentrations examined. The extracting species were isolated and characterized by analyses and ir spectra. $Zr(DBMPA)_2$ and $Hf(DBMPA)_2$ complexes were extracted into the organic phase, and in the presence of a large excess of metal ions in the aqueous phase the species $MeSO_4DBMPA$, $MeCl_2DBMPA$, and $Me(ClO_4)_2DBMPA$ (Me = Zr or Hf) were isolated from the interface. (auth) (UK)

44430 RARE METALS EXTRACTION IN INDIA. Sundaram, C. V.; Saratchandran, N. (Bhabha Atomic Research Centre, Trombay, India). pp 251-309 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Processes that have been adapted in India for the extraction of rare metals include: physical ore beneficiation, selective chemical ore-breakdown techniques, ion exchange, solvent extraction, metallothermic reduction, extraction by molten salt electrolysis, and consolidation and vacuum refining. Details are given on the production of Th, U, Zr, Hf, Ti, and the rare earths. (J.G.B.)

44431 SEPARATION OF HYDROGEN AND NITROGEN ISOTOPES IN THE DISSOCIATION AND SYNTHESIS OF AMMONIA IN A SILENT ELECTRIC DISCHARGE. Salimova, K. M.; Semiokhin, I. A.; Panchenkov, G. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 44: No. 10, 1446-8(Oct 1970).

The redistribution of nitrogen and hydrogen isotopes in the dissociation and synthesis of ammonia in a silent discharge was investigated. The undecomposed part of ammonia is enriched on dissociation in deuterium with a separation factor of 1.43 ± 0.03 and in the rare ^{15}N with a separation factor 1.008 ± 0.005. The ammonia formed in a silent discharge is depleted in deuterium with a separation factor of 0.71 ± 0.03 and enriched in ^{15}N with a separation factor of 1.040 ± 0.010. (auth)

44432 PRECIPITATION OF SOME ACTINIDE ELEMENT COMPLEX IONS BY USING HEXAMMINE COBALT(III) CATION. II. THE PRECIPITATION OF THORIUM, URANIUM(VI), AND PLUTONIUM(IV), (VI) SULFATE COMPLEX IONS WITH HEXAMMINE COBALT(III) CATION. Ueno, Kaoru; Hoshi, Michio (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 6, 1765-73(Jun 1971).

The precipitation behavior of thorium, uranium(VI), neptunium(V), plutonium(IV), (VI), and americium(III) in an ammonium sulfate solution with hexammine cobalt(III) ion was studied. Orange colored precipitates were produced in the case of thorium, uranium(VI), and plutonium(VI), and green yellow colored precipitate was produced in the case of plutonium(IV), respectively. On the other hand, no precipitate of neptunium(V) and americium(III) was observed under the same conditions. The compositions of the thorium, uranium(VI), and plutonium(IV) compounds were, respectively, di-[hexammine cobalt(III)][thorium pentasulfate] dihydrate, $[CO(NH_3)_6]_2[Th(SO_4)_5] \cdot 2H_2O$, di{[hexamine cobalt(III)]bisulfate} [uranium(VI) dioxo trisulfate] pentahydrate, $\{[Co(NH_3)_6] \cdot HSO_4\}_2[UO_2(SO_4)_3] \cdot 5H_2O$, and di[hexammine cobalt(III)][plutonium(IV) pentasulfate]trihydrate, $[CO(NH_3)_6]_2\ [Pu(SO_4)_5]3H_2O$. Chemical and crystallographic properties of the three compounds and crystallographic property of the plutonium(VI) compound were also studied. (auth) (UK)

44433 ION EXCHANGE EQUILIBRIA IN SYNTHETIC ZEOLITE 4A IN A MIXED SOLVENT SYSTEM. Radak, V. M.; Susic, M. V. (Inst. of Chemistry, Technology, and Metallurgy, Belgrade). J. Inorg. Nucl. Chem.; 33: No. 6, 1927-31(Jun 1971).

The ion exchange behavior of alkali metal ions on synthetic zeolite 4A in the water–methanol system was studied as a function of D, the macroscopic dielectric constant of the external solution. The anomalous behavior of Li^+ in the presence of organic solvent was observed. Applying a statistical-thermodynamic treatment, thermodynamic equilibrium constants were determined;

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from these the standard free energies of exchange were evaluated for the systems $Na^+ \rightleftharpoons M^+$ ($M^+ = Li^+$, K^+, Rb^+, and Cs^+) in a 50 mole % water–methanol mixture. The thermodynamic affinity sequence, based on the standard free energies of exchange, is $Na^+ > K^+ > Rb^+ > Cs^+ > Li^+$. (auth) (UK)

44434 ALIPHATIC SULFOXIDES IN LIQUID–LIQUID EXTRACTION; URANYL NITRATE EXTRACTION. Chaieb, Mohamed Tahar; Laurence, Guy (Ecole Nationale Superieure de Chimie, Paris). Energ. Nucl. (Paris); 13: No. 2, 106-13(Mar-Apr 1971). (In French).

After reviewing the physical chemistry of uranyl nitrate extraction by TBP and comparing it with dipolar solvents, linear aliphatic sulfoxides (R_2SO) are shown to have interesting characteristics for liquid–liquid extractions. Uranyl nitrate liquid–liquid extraction by various sulfoxides diluted in 1,1,2-trichloroethane is described. The yields obtained are comparable with those obtained using TBP. (France)

44435 BASIC EXPERIMENT ON THE REMOVAL OF RADIOACTIVITY FROM WATER. 2. Kobayashi, Ugoro (Niigata Univ., Nagaoka, Japan); Oseki, Saburo; Yamamoto, Hisa; Kuroda, Reiko. Suido Kyokai Zasshi; No. 433, 26-34(Oct 1970). (In Japanese).

Experiments were made on the removal of radioactivity from water. The purpose was to remove radioactive fission products in (FP's) in town water due to the fallout in precipitation. Test water was prepared by adding fission products, ^{137}Cs, and ^{90}Sr to either river water or town water. Flocks were formed using coagulants. To enhance decontamination, the supernatant was filtered. The coagulant is $Al_2(SO_4)_3 \cdot 18H_2O$; the auxiliary coagulant is $Ca(OH)_2$ or Na_2CO_3. Adhesion and precipitating agents used in some cases are active carbon, and $CaCl_2 + Na_2HPO_4 \cdot 12H_2O$, respectively. The decontamination was dependent largely on the isotope, muddiness, and pH. As a whole, the FP was easier to remove than Sr or Cs. (MORI, K.) (Japan)

44436 INVESTIGATING THE SEPARATION OF TRACE ELEMENTS BY PRECIPITATION AND EXTRACTION. Upor, E. Kem. Kozlem.; 34: No. 1, 45-71(1970). (In Hungarian).

The sorption on metal hydroxides in the course of precipitation separation of trace elements was studied. The sorption of UO_2^{2+} on metal hydroxides in carbonate and alkali metal hydroxide-containing media and the desorbent action of thorium on the sorption of uranium(IV) in carbonate media were investigated. General conclusions were drawn and the experimental results were utilized in the elaboration of analytical methods. The extraction properties of alkyl phosphoric acid esters and the synergetic and antagonistic phenomena with dialkyl phosphoric acids and various additives were studied. Extraction with alkyl phosphoric acid esters was utilized in the elaboration of eleven analytical methods. A brief survey of trace analytical methods is presented; including analytical methods based on the application of Arsenazo III reagent, combined extraction and photometric trace analytical methods, neutron activation procedures, emission spectrum analysis, and derivatography. (Hung. Tech. Abstr.)

44437 SOLVENT EXTRACTION OF NEPTUNIUM(V) AND SOME FISSION PRODUCTS BY MIXTURE OF TRIBUTYL PHOSPHATE WITH ALKYL-AMMONIUM NITRATES. Puzic, R. G.; Maksimovic, Z. B. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 21: No. 4, 27-32(Dec 1970).

The distribution of neptunium(V), europium(III), and niobium between nitric acid solutions and organic phases containing tributyl phosphate (TBP) and trilaurylammonium (TLAN) or trilaurylmethylammonium (TLMAN) nitrates in hexane or toluene as diluents was studied. A slight synergic effect was observed in the extraction of neptunium(V) and europium(III). (auth)

44438 GENERALIZED SYSTEM OF EQUATIONS DESCRIBING SEPARATION OF MULTICOMPONENT ISOTOPIC MIXTURES. Partsakhashvili, G. L. Soobshch. Akad. Nauk Gruz. SSR; 63: No. 1, 53-6(Jul 1971). (In Russian).

A system of equations is presented describing separation of multicomponent isotopic mixtures when the arbitrary intermolecular exchange rate is taken into account. The system is described as applied to simultaneous separation of oxygen and nitrogen isotopes by low-temperature distillation. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 44312, 44338, 44480, 44560, 44714, 44715, and 44727.

44439 (BNWL–1220) FIXATION OF RADIOACTIVE WASTES IN SOIL AND SALT CAKES WITH ORGANIC POLYMERS. Mercer, B. W.; Shuckrow, A. J.; Ames, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1971. Contract AT-(45-1)-1830. 47p. Dep. NTIS.

Organic polymers of the type used in fiberglass laminates were evaluated for use in the fixation of radioactivity in soil and preformed salt cakes. In situ fixation of the radioactivity is to be accomplished by injection of the polymers into soil or preformed salt cakes. This approach circumvents the costs and hazards associated with the alternate method of excavating the highly radioactive soil or salt for processing or burial. The results of laboratory studies show that water leach rates of radioisotopes or ions from the soil and salt cakes were reduced by 99.9% or more by incorporation of the soil or salt in a suitable resin matrix. Injection of catalyzed liquid resin into soil with subsequent polymerization to form a hard mixture was demonstrated in both laboratory and field experiments. (auth)

44440 (NYO–844–84, pp 6–11) SEARCH FOR ANOMALOUS ALPHA ACTIVITY IN NATURAL MATERIALS. Trivedi, Brij M. P. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

Experiments were performed to determine any unknown volatile alpha activity in rocks, specifically in Conway granite. Pulverized rock samples were subjected to long-term heating at temperatures of 200, 400, 600, and 800°C. The volatile material obtained was condensed and counted for alpha activity in the 0 to 16 MeV range. The results did not indicate any unknown volatile alpha activity in Conway granite samples. (L.C.L.)

44441 (NYO–844–84, pp 48–53) SEARCH FOR NATURAL RADIOACTIVITY OF ^{48}Ca. Yeager, Mark J. (Carnegie Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

A radiochemical purification procedure is described for extracting active-daughter ^{48}Sc from large amounts of Ca in order to test for the natural radioactivity of ^{48}Ca. The beta counting system used is discussed, and it is recommended that the future experiments employ a $\gamma-\gamma$ coincidence counting system. (L.C.L.)

44442 (USGS–474–99) U.S. GEOLOGICAL SURVEY TRACER STUDY, AMARGOSA DESERT, NYE COUNTY, NEVADA. PART II. AN ANALYSIS OF THE FLOW FIELD OF A DISCHARGE-RECHARGING PAIR OF WELLS. Grove, David B. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 56p. Dep. NTIS.

Two transport models, plug flow and dispersed flow, were used to evaluate the flow field between a discharging-recharging pair of wells. A numerical solution for the plug-flow model resulted in plots of dimensionless groups that allow prediction of travel times between wells along streamlines. A numerical solution for the dispersed-flow model allows evaluation of the porosity and dispersion constant of the aquifer. The technique is applicable for pulse tracer injection and recirculation. The computer program is presented. (auth)

44443 (USGS–474–107) RADIOCHEMICAL ANALYSES OF WATER SAMPLES FROM SELECTED STREAMS AND PRECIPITATION COLLECTED IN CONNECTION WITH CALIBRATION-TEST FLARING OF GAS FROM TEST WELL, AUGUST 15–OCTOBER 13, 1970, PROJECT RULISON. Rulison-8. Claassen, Hans C.; Voegeli, Paul T. Sr. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 10p. (PNE-R–49). Dep. NTIS.

Data from samples collected from August 15, 1970 through October 13, 1970 are presented and the published data through the calibration flaring phase of the project are updated. (D.H.M.)

44444 (USGS–474–108) RADIOCHEMICAL ANALYSES OF WATER SAMPLES FROM SELECTED STREAMS AND PRECIPITATION COLLECTED OCTOBER 23–NOVEMBER 9, 1970, IN CONJUNCTION WITH THE FIRST PRODUCTION-TEST FLARING OF GAS FROM TEST WELL, PROJECT RULISON. Rulison-9. Claassen, Hans C. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 10p. (PNE-R–50). Dep. NTIS.

All of the precipitation samples and some of the stream samples are routinely analyzed for tritium. Two of the stream samples, those collected at Plateau Creek near Cameo, Colorado, and Colorado River near DeBeque, Colorado, are routinely analyzed for gross alpha and gross beta. Should above-background values be noted for any of the samples analyzed, other samples collected but held in storage will be analyzed, and the sampling frequency increased. Data are presented in tabular form. (D.H.M.)

44445 (USGS–474–113) STRATIGRAPHIC SECTION FOR SOUTHEASTERN MISSISSIPPI. Eargle, D. Hoye (Geological Survey, Denver, Colo.). 1962. Contract AT(29-2)-474. 2p. Dep. NTIS.

The stratigraphic section for southeastern Mississippi is presented in tabular form for use by participants of Project Dribble of the Vela Uniform Program. The site for Project Dribble is Tatum salt dome, Lamar County, Miss., and the purpose of the project is the improvement of seismic detection of underground explosions. Tatum salt dome is near the center of southeastern Mississippi. (auth)

44446 (USGS–474–116) COMPLAINTS RELATED TO WATER WELLS AFTER SALMON EVENT IN TATUM SALT DOME AREA, LAMAR COUNTY, MISSISSIPPI. Dribble-46. Taylor, R. E. (Geological Survey, Denver, Colo.). 1965. Contract AT(29-2)-474. 17p. Dep. NTIS.

Almost immediately after the Salmon Event at Tatum Dome on Oct. 22, 1964, the U. S. Geological Survey, Water Resources Division, began receiving complaints of damage to water wells. Most of the complaints were received within the first 15 days after the detonation. However, a few complaints were filed almost every week since that time. All complaints received are investigated to various degrees. The most distant well is about 65 miles from surface-ground-zero. Well owners' complaints have concerned either a change in water quality (largely turbidity and color) or a decrease in well yield, or both. Investigations of water quality complaints have determined that the problem either cleared up in a few days or is inherent to the particular well system. Removing various well or pump components has revealed that a decrease in well yield can be attributed either to foreign matter falling into the bottom check valve or the well system was in various stages of normal deterioration. There has been no complaint-damage orientation pattern. Investigations to date have revealed that not one well suffered structural damage as a result of the Salmon Event but that the detonation probably manifested already existing well conditions. Screens removed from several of the wells were found to be in various stages of rust incrustation and corrosion caused by the natural environment prior to the nuclear explosion. Normal seasonal water level decline in the area probably contributed to the number of well-failure complaints in Oct. and Nov. 1964. (auth)

44447 (USGS–474–127) FINAL INVESTIGATIONS OF WATER-WELL COMPLAINTS RELATED TO SALMON EVENT IN TATUM SALT DOME AREA, LAMAR COUNTY, MISSISSIPPI. Dribble-46, Supp. 1. Taylor, R. E. (Geological Survey, Denver, Colo.). 1966. Contract AT(29-2)-474. 29p. Dep. NTIS.

On Oct. 22, 1964, the day of the 5-kt nuclear detonation (Salmon Event), the U.S. Geological Survey and the USAEC began to receive inquiries and complaints about the operation of water wells and one spring in the area around Tatum dome. On the same day, the Survey began to investigate these complaints. Inquiries and complaints were received until Dec. 1965 and the investigations were completed in May 1966. A total of 139 inquiries and complaints were filed on 142 wells and 1 spring. The difference between this number (139) and the number of wells and one spring (143) is explained by the fact that four complainants reported two wells each. Inspection of screens removed from 44 closed wells (31% of all complaints) revealed that closed-screened wells had incurred no visible structural damage but that a few motors had been damaged. The problems in most wells were due to normal well deterioration and declining water level. A preshot water-well inventory is probably one of the best means of lessening the number of complaints, of facilitating postshot investigations, and of documenting water and well conditions. (auth)

44448 EFFECT OF γ-RADIATION ON THE PROCESS OF GROWTH OF VISCOUS MAGNETIZATION OF ROCKS. Brodskaya, S. Yu. Izv. Akad. Nauk SSSR, Fiz. Zemli; No. 7, 70–6 (1970). (In Russian)

Curves of viscous magnetization are compared for rocks subjected and not subjected to gamma irradiation. In the rocks studied the growth of viscous magnetization in the various ferromagnetic grains was the same. One relaxation process on which gamma irradiation had practically no effect, and another process with a com-

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plex distribution function on which it had a substantial effect, could be detected. (Geophys. Abstr.)

44449 FOSSIL TRACK STUDIES IN TERRESTRIAL MATERIALS: GEOCHRONOLOGY, GEOPHYSICS, AND ARCHEOLOGY. Pellas, P. (CNRS, Paris. Museum National d'Histoire Naturelle, Paris). pp VI.2-4 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Geochronological laboratories must use simultaneously classical and fission traces dating methods. The results obtained with the fission traces method are enumerated. (France)

44450 CORRECTION METHOD FOR THERMALLY LOWERED FISSION TRACK AGES. Storzer, D.; Wagner, G. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp VI.20-5 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Owing to natural annealing effects, fission track ages are often lower than other radiometric ages. In long time laboratory experiments the annealing conditions were simulated for different glasses. With increasing duration or temperature applied, both number and diameter of the etched tracks decrease in a characteristical manner. By measuring the size of fission track etch pits in a natural sample the track number reduction can be inferred and thermally lowered fission track ages may be corrected. In addition to the age correction, size distributions of fission track etch pits reveal the thermal history of a sample. This correction method was successfully applied to tektites, related glasses, and other natural glasses. Preliminary results indicate applicability for apatites also. (auth) (France)

44451 DISTRIBUTION OF THE SHORT-LIVED DAUGHTER PRODUCTS OF RADON ON AEROSOL PARTICLES IN MINE AIR. Savenko, E. I.; Serdyukova, A. S. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 3, 123-7(1970). (In Russian).

In mines where there is no drilling the maximum distribution of short-lived daughter products of radon by aerosol particle size corresponds to a mean particle diameter of about 0.03 microns. On the average, along the whole cleaned mine face tested, about 90 percent of the particles carrying the radon daughter products were less than 0.09 microns in size, with maximum distribution at a mean diameter of 0.065 microns. In the range of dust contamination from 1.4 to 2.1 mg/m^3, maximum distribution of radon daughter products was shifted toward larger aerosol particles (0.055 to 0.072 microns). (Geophys. Abstr.) (D.B.V.)

Meteorology

Refer also to abstracts 44412, 44586, 44602, 44731, and 44801.

44452 (NRL-F-42) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND. Quarterly Report, October–December 1970. (National Radiation Lab., Christchurch (New Zealand)). 16p. Dep. NTIS (U. S. Sales Only).

The results of routine monitoring of fallout in New Zealand during the fourth quarter of 1970 are presented and include measurements of the total beta activity of atmosphere and rainwater samples, ^{90}Sr content of rainwater, and the ^{137}Cs and ^{90}Sr contents of milk. It is concluded that the amount of radioactive fallout measured increased due to the 1970 French nuclear tests, but that the levels of radioactivity do not constitute a public health hazard. (L.C.L.)

44453 (NYO-3086-10(Vol.2), pp III.1-24) INVESTIGATION OF THE ATTACHMENT CHARACTERISTICS OF ^{222}Ra DAUGHTERS TO NATURALLY OCCURRING AEROSOLS. Van Pelt, Wesley R.; Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine).

From Radioactivity studies.

Research was performed to determine the manner in which the short-lived daughters of ^{222}Rn (^{214}Bi, ^{210}Pb, ^{214}Pb, ^{214}Po, and ^{218}Po) attach to naturally occurring aerosols containing particles of from 0.015 to 1.0 μm dia. A review of the literature is presented. The equipment and methods used in the seven experiments performed are described. The results so far indicate that the kinetic theory of interaction is a more correct theory for ^{222}Rn daughter interaction with natural aerosols than is the classical diffusion theory. Further experimentation and data analysis are recommended. (L.C.L.)

Mineralogy and Exploration

Refer also to abstract 45033.

44454 (TID-25733) STATISTICAL DATA OF THE URANIUM INDUSTRY. (Grand Junction Office (AEC), Colo.). 1 Jan 1971. 54p. Dep. NTIS.

A compilation is presented of historical facts and figures and the current status of the US uranium industry as of Jan. 1, 1971. Information is included on: ore and concentrate purchases; uranium resources; distribution of deposits; drilling statistics; land acquisition for uranium mining and exploration; employment; domestic U_3O_8 sales and projected requirements; and processing mills. (L.C.L.)

44455 (TID-25759) 1969 PROGRESS REPORT [ON URANIUM IN ORE DEPOSITS OF SOUTHERN COLORADO PLATEAU]. (Columbia Univ., New York). Contract AT(30-1)-1936. 9p. Dep. NTIS.

Research for 1969 involved a group of studies directed toward increased knowledge of the emplacement of uranium in ore deposits of the southern Colorado Plateau. The research was concerned particularly with vertical structures connected with uranium deposition in the vicinity of La Bajada and Grants, New Mexico, at Marysvale, Utah, and at Garnet Ridge and Grand Canyon, Arizona. Further, laboratory studies were devoted to samples illustrating the organic environment associated with uranium deposition from samples collected previously at numerous localities on the Colorado Plateau. (auth)

44456 EXTRACTIVE METALLURGY OF URANIUM. Merritt, Robert C. Golden, Colo.; Colorado School of Mines Research Institute (1971). 592p. (TID-25711).

The status of the U ore processing industry from 1967 through 1968 is reviewed. The information is presented in chapters on U minerals, processing, preparation, extraction, and concentration. Other chapters contain information on U milling plants. (J.R.D.)

44457 SCHMITTERITE: A NEW URANYL TELLURITE FROM MOCTEZUMA, SONORA. Gaines, Richard V. (Univ. de Mexico, Mexico City). Amer. Mineral.; 56: No. 3-4, 411-15(Mar-Apr 1971).

A new mineral, uranyl tellurite UO_2TeO_3, was found at the Moctezuma Mine, Moctezuma, Sonora. The mineral is pale straw yellow in color and occurs in minute rosettes of micaceous crystals, usually associated with emmonsite. It is orthorhombic, space group Pmab with a = 7.860, b = 10.089, and c = 5.363 Å; there are four formula units per cell, H = 1; G = 6.878 (measured), 6.916 (calculated). The mineral is biaxial negative with indices above 2.00. Principal powder lines are 3.682 (10), 5.35 (9), 3.099, (9), 4.73 (8), 3.170 (8), and 1.971 (7). The name is for Eduardo Schmitter V. of the University of Mexico. (auth)

Oceanography

Refer also to abstracts 44712 and 44713.

44458 (RLO-1725-193) VELOCITY, TEMPERATURE, AND PRESSURE OBSERVATIONS FROM MOORED METERS ON THE SHELF NEAR THE COLUMBIA RIVER MOUTH, 1967–1969. Special Report No. 45. Hopkins, Thomas S. (Washington Univ., Seattle. Dept. of Oceanography). May 1971. Contract AT(45-1)-1725. 143p. (M-71-27). Dep. NTIS.

A description and the results of measurements taken from instruments moored off the Washington–Oregon coast are presented. Time series of horizontal velocity, temperature, and pressure fields were recorded intermittently between July 1967 and October 1969. The instruments were installed mostly near the bottom on taut wire moors located in the proximity of the Columbia River mouth. (auth)

44459 (RLO-1725-194) BAROTROPIC TIDE OVER THE CONTINENTAL SHELF OFF THE WASHINGTON–OREGON COAST. Special Report No. 46. Hopkins, Thomas S. (Washington Univ., Seattle. Dept. of Oceanography). May 1971. Contract AT(45-1)-1725. 22p. (M-71-28). Dep. NTIS.

The tides along the Washington–Oregon coast and the varia-

tions with latitude of the amplitude and phase of the major tidal constituents are discussed. Surface elevations obtained from pressures recorded from 1967 to 1969 at a fixed location (46°25'N 124°20'W) approximately 35 km off the Columbia River mouth and 80 m depth are compared with predicted values. Tidal velocity components computed from direct current observations at the above location are also compared with computed values. The program of harmonic analysis and the tide filter used in the analysis are discussed. (auth)

44460 FISSION TRACK DATING OF VOLCANIC GLASS SHARDS IN MARINE SEDIMENTS. Macdougall, D. (Scripps Institution of Oceanography, La Jolla, Calif.). Earth Planet. Sci. Lett.; 10: 403-6(Mar 1971).

The fission track dating method is applied to glass shards from volcanic ash layers in deep sea sediments which have also been dated by other methods. Measured ages for three samples are in excellent agreement with previously determined K-Ar, paleomagnetic and paleontologic ages. The fission track method of dating of glass shards seems to offer itself as a valuable tool for dating marine sediments. (auth)

44461 CHRONOLOGICAL TEST OF OCEAN BOTTOM SPREADING IN THE NORTH ATLANTIC. Fleischer, R. L. (General Electric Co., Schenectady, N. Y.); Viertl, J. R. M.; Price, P. B.; Aumento, F. pp VI.14-19 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A model of ocean bottom spreading in the North Atlantic is that fresh warm material is upwelling at the median valley of the ridge system and pushing out laterally on either side, giving rise to ocean bottom spreading away from the valley and possibly supplying the impetus for the inferred drift of the continents. In principle, either K–Ar or fission track dating is a means for making a chronological test of the above model. In fact, the methods are complementary and both are necessary in order to span the necessary time interval. The assembled K–Ar and fission track dates are presented, as a function of distance from the center line of the ridge system. With one exception the ages increase monotonically. (France)

Seismology

Refer also to abstract 44445.

44462 (USGS-474-109) SEISMICITY OF THE CENTRAL NEVADA TEST AREA, 26 SEPTEMBER 1969–1 OCTOBER 1970. Smith, B. E.; Hamilton, R. M.; Jackson, W. H. (National Center for Earthquake Research, Menlo Park, Calif.). 1971. 27p. Dep. NTIS.

The U. S. Geological Survey operated seven seismograph stations in the vicinity of the Central Nevada Test Area (CNTA), Hot Creek Valley, for a period of about one year. Locations were determined for 36 earthquakes. A few of the larger shocks were located with additional recordings from stations elsewhere in Nevada. Earthquake activity was observed in Hot Creek Valley, Little Fish Lake Valley, and northern Stone Cabin Valley. Magnitudes ranged from −0.2 to 3.4. Depths of focus ranged from 0.6 to 12.2 km. A composite first-motion plot for 21 earthquakes yielded a fault-plane solution consistent with a strike-slip pattern striking approximately N40°E (right-lateral) or N50°W (left-lateral). Large underground nuclear explosions at NTS did not stimulate earthquake activity at CNTA. The infrequent seismic activity at CNTA suggests that any earthquakes closely following a future explosion probably have been initiated by that explosion. (auth)

XUM

ENGINEERING

Nuclear Explosions

Refer also to abstracts 44443, 44444, 44446, 44447, 44462, 44570, and 44731, 45030.

44463 (AD–719669) DEMOLITIONS, ATOMIC. Materiel Test Procedure. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md.). 27 Aug 1969. 13p. (MTP–4–3–46). NTIS.

The objective of the Materiel Test Procedures is to describe the service test procedures required to determine the operational effectiveness of atomic demolitions and their associated activation equipment, measured against the requirements specified in the applicable Qualitative Materiel Requirement or Small Development Requirement, and the suitability of such items for military use. (auth) (USGRDR)

44464 (ARLV–351–18) MICROSCALE INVESTIGATION OF THE TEMPORAL CHANGES IN THE BUGGY I BASE-SURGE CLOUD. Randerson, Darryl (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Air Resources Lab.). Mar 1971. 11p. (NOAA-TM-ERL-ARL–30). Dep. NTIS.

A microscale analysis is presented to describe the temporal changes in the base-surge cloud generated during a Plowshare nuclear cratering event on the Nevada Test Site. The analysis shows that the inertial motion of the base-surge cloud dissipated within 1 min after detonation, so that after H + 1 min, the displacement of the cloud was governed by the local air flow. The use of aerial photography for conducting investigations of early-time cloud dynamics is also demonstrated. (auth)

44465 (JAB–99–48) MONITORING STUDY OF BUILDING ELEMENT CRACK MOVEMENTS. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jul 1971. Contract AT(26-1)-99. 49p. Dep. NTIS.

Structures in Southern Nevada and in the Rulison, Colorado, area have been subjected to dynamic ground motion generated by underground nuclear test detonations. To determine what effect this ground motion might have on structures in the subject areas, a number of existing cracks in building elements were instrumented and monitored. In comparing event-related maximum crack movement with observed minor low-rise building damage, good correlation was seen for data from the Rulison area. Such minor damage was observed there at spectrum intensities as low as V_v = 7.0 cm/sec. V_v is defined as the vector of radial and tangential components of 5% damped response spectrum velocity averaged over the period range of 0.05 to 0.2 seconds. No event-related maximum crack movement was observed for monitored Southern Nevada low-rise structures outside the Nevada Test Site (NTS). One instance of event-related maximum crack movement was noted for Mercury, Nevada, structures located on the Nevada Test Site. The response spectrum vector velocity, V_v, observed for this movement was approximately 0.1 cm/sec. Although this appears to be an anomalously low response intensity with regard to damage, it cannot be completely disregarded at this time. (auth)

44466 (ORNL–TM–3480) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE): PROGRESS REPORT FOR JANUARY 1–MARCH 31, 1971. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). 2 Jul 1971. 14p. Dep. NTIS.

In tests simulating storage of natural gas in a cavity formed with nuclear explosives, tritiation of methane by exchange with tritiated water in the storage vessel was essentially negligible for storage periods of about 30 days. Efficient removal of tritiated water vapor from the effluent gas, however, would probably be required. About 90% of the tritiated water was removed from Lewis shale or salt samples prior to gas storage by purging the storage vessel with moist air. (auth)

44467 (PNE–1550) FEASIBILITY STUDY OF A PLOWSHARE GEOTHERMAL POWER PLANT. (American Oil Shale Corp., Salt Lake City, Utah. Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. California Univ., Livermore. Lawrence Radiation Lab.). Apr 1971. 177p. Dep. NTIS.

A study was conducted to determine the feasibility of producing electric power from geothermal energy by using deep underground nuclear explosions to fracture large quantities of hot rock, piping water to the fractured rock to create steam, and using the steam to operate turbine-generators in a power plant. Condensed steam from the power plant would be recycled to the fractured region. The closed system design and deep containment of the explosion would guard against release of radioactivity to the environment. The factors studied included: site considerations; development of the geothermal heat source using underground nuclear explosions; methods for heat extraction; power plant operation; and costs and economic analysis. It was concluded that there is no technical reason why electric power cannot be produced from geothermal heat sources with the aid of nuclear explosions. The problems involved and areas in which further research is necessary to prove economic desirability of this method of producing electric power are identified. Further laboratory and field tests are recommended. (L.C.L.)

44468 (TID–25708) PUBLIC SAFETY AND UNDERGROUND NUCLEAR DETONATIONS. Glasstone, Samuel (Atomic Energy Commission, Washington, D. C.). Jun 1971. 276p. Dep. NTIS.

The USAEC comprehensive safety programs for protecting the public from the effects of underground nuclear explosions, particularly tests in the Plowshare Project, are described and explained. Information is presented on: current status of Plowshare tests; potential hazards in nuclear detonations; basic principles of nuclear explosions; phenomena associated with underground explosions; the importance of geologic and hydrologic studies of test sites in assuring that water supplies will not be contaminated by underground nuclear explosions; ground motion effects and the response of structures; seismic effects and water wave phenomena; meteorology and safety predictions; radiological safety program; bioenvironmental safety program; safety controls for nuclear detonations; and nuclear excavation safety. (L.C.L.)

44469 (TID–25715(Vol.1)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIXES 1–4. (Atlantic–Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 253p. (AD–721168). Dep. NTIS.

Four appendixes of information related to studies of the engineering feasibility of constructing an Atlantic–Pacific interoceanic canal are presented. The first describes the climate, terrain, geology, and state of development of sites considered as possible routes for either lock or sea level canal construction. The second and third discuss the present state of the art of excavation by conventional and nuclear methods. The final appendix presents information on the management, organization, and funding of the interoceanic canal project. (L.C.L.)

44470 (TID–25715(Vol.2)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIXES 5–8. (Atlantic–Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 222p. (AD–721169). Dep. NTIS.

The state of the art for determining the effects of the tidal and hydrologic environment on a sea level canal across the American Isthmus is presented. The construction of a sea level canal across the American Isthmus would connect two bodies of water with widely varying tidal characteristics. Periodic changes in water levels at the canal extremities would generate currents varying with time in both magnitude and direction. The difference in mean sea levels between the oceans would result in a net transfer of water from the Pacific Ocean to the Atlantic Ocean. Freshwater inflow from intercepted streams would have a tendency to flow over the salt water in the canal and cause density currents. The tidal hydraulics and freshwater inflow are discussed from the general standpoint for sea level canals in the isthmian area. Problems associated with particular routes and their solutions are discussed in separate route appendixes. Discussions of the following are included: tidal environment in the area of study; methods for computing currents; mathematical model analysis to determine effects of canal characteristics on tidal currents; net transport of water between oceans; density currents resulting from freshwater inflow; and measures for reducing tidal and density currents. (auth)

44471 (TID–25715(Vol.3)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIXES 9–11. (Atlantic–Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 299p. (AD–721170). Dep. NTIS.

A conceptual evaluation of a lock canal is presented to establish a standard against which the various sea level alternatives can be measured. The lock canal should be capable of transiting vessels up to 150,000 dwt and attaining an annual capacity of 35,000 transits. The potential capacity of the existing canal and its water supply are examined. A conceptual plan of improvement is developed which combines the best features of plans considered in prior studies. A lane of new large locks would be provided to supplement the capacity of the existing canal. A detailed analysis of

the large locks is presented. Methods of augmenting the water supply and a plan of pumping water into Gatun Lake are examined. Effects of pumping salt water into the lake are discussed. Initial construction costs and annual operating costs for the conceptual plan of improvement are presented. (auth)

44472 (TID–25715(Vol.4)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIXES 12–14. (Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 352p. (AD–721171). Dep. NTIS $6.00.

The engineering feasibility of constructing a sea level Atlantic Ocean to Pacific Ocean canal is presented in three separate appendixes. The first evaluates canal construction along Route 17 in the Darien Province of eastern Panama. The second examines the use of combined conventional and nuclear methods for constructing a sea level canal along Route 25 across the American Isthmus in northern Colombia. The last deals with Route 23 which runs between Miguel Bay on Panama's Pacific Coast and Candelaria Bay on the Atlantic Coast of Colombia. Each route study, based on previously obtained exploratory data, estimates the effects of the proposed canal construction on the surrounding environment, the safety of the excavation methods considered, the time schedule required, and the cost. (L.C.L.)

44473 (TID–25715(Vol.5)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIXES 15–16. (Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 312p. (AD–721172). Dep. NTIS.

The Atlantic–Pacific Interoceanic Canal Study Commission was established to determine the engineering feasibility of constructing a sea level canal by either conventional or nuclear methods across the American Isthmus, to ascertain the most suitable site for such a canal, and to estimate its cost. The organization and cost of this 8-year study are discussed in detail. A separate appendix examines the ecological issues implicit in the construction of such a canal with specific reference to the marine environment, and outlines a research program for assessing the ecological impact of a canal and for minimizing the damage which might occur. (L.C.L.)

44474 (TID–25715(Vol.6)) INTEROCEANIC CANAL STUDIES. ANNEX V. STUDY OF ENGINEERING FEASIBILITY. APPENDIX 17. (Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.). Dec 1970. 203p. (AD–721173). Dep. NTIS.

A 99-page bibliography is presented of references published prior to Nov. 1970 which are pertinent to the study of the engineering feasibility of constructing an Atlantic–Pacific interoceanic canal across the American Isthmus. A subject index, keyword list, and two code lists are included with the bibliography for ease in document search and identification. (L.C.L.)

44475 (TID–25722) INTEROCEANIC CANAL STUDIES, 1970. (Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.). 1 Dec 1970. 1047p. (AD–721417). Dep. NTIS $12.00.

The final report of the Atlantic–Pacific Interoceanic Canal Study Commission is presented. The Commission was established to determine the feasibility of, and the most suitable site for, the construction of a sea level canal connecting the Atlantic and Pacific Oceans; the best means of constructing such a canal, whether by conventional or nuclear excavation; and the estimated cost thereof. The Commission also evaluated the merits of improving and augmenting the existing Panama Canal to accommodate forecast traffic. Information is included on: Isthmanian canal interests of the U.S. and other nations; foreign policy considerations; national defense aspects; potential canal traffic and revenues; environmental considerations; analysis of alternatives; financial feasibility; and the management of sea level canal construction and operation. The principle conclusions of the study were that: nuclear excavation technology is not yet sufficiently advanced to be considered feasible or safe for canal construction; construction by conventional excavation methods is physically feasible; the most suitable site for such a canal is on Route 10 in the Republic of Panama; and the cost would be $2.88 billion at 1970 price levels. It is recommended that the U.S. negotiate a treaty with Panama to provide for a unified canal system comprising both the existing canal and a sea level canal on Route 10, to be operated and defended under effective control of the U.S. with participation by Panama, and that, if the treaty is negotiated and funds are available, construction of this canal system should be initiated in the 1980's. (L.C.L.)

44476 (UCRL–50635(Rev.2)) PROJECT GASBUGGY: GAS QUALITY ANALYSIS AND EVALUATION PROGRAM TABULATION OF RADIOCHEMICAL AND CHEMICAL ANALYTICAL RESULTS. Smith, Charles F. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Apr 1971. Contract W-7405-eng-48. 27p. (PNE-G–44(Rev.2)). Dep. NTIS.

A tabulation is presented of analytical results for samples of Project Gasbuggy chimney gas that attempts to summarize all of the previous results with a consistent up-to-date listing of samples, radionuclide concentrations, and chemical analysis results. The listing includes the description and the disposition of all samples obtained for analysis at the Lawrence Radiation Laboratory following the Gasbuggy detonation. Radiochemical results expressed as concentrations in chimney or formation gas are given for ^{85}Kr, HT, HTO, CH_3T, C_2H_5T, C_3H_7T, $^{14}CO_2$, ^{37}Ar and ^{39}Ar. Upper limits for the concentrations of several nongaseous or semivolatile nuclides are presented. The tabulation also includes the percentages of N_2, CO_2, CO, H_2, CH_4, C_2H_6 and C_3H_8 in the sample gas as determined by mass spectrometry. (auth)

44477 (UCRL–51034) BEHAVIOR OF STEMMING MATERIALS UNDER STRESS. Blake, Alexander; Zaslawsky, Maurice (California Univ., Livermore. Lawrence Radiation Lab.). 15 Apr 1971. Contract W-7405-eng-48. 54p. Dep. NTIS.

Granular materials such as sand and gravel are used to fill or "stem" the emplacement hole for an underground nuclear test. The results are presented of experimental and theoretical investigations of the behavior of downhole pipe surrounded by such stemming material when subjected to shock from the nuclear explosion and to stresses arising during the emplacement procedure. The principal effects investigated experimentally were: longitudinal friction between the pipe and the stemming material; and resistance offered by the stemming material to transverse motion of the pipe. Design criteria for emplacement systems are given, and some material properties are presented for Overton sand and pea gravel, two widely used stemming materials at the Nevada Test Site. (auth)

44478 (UCRL–51062) GROUND MOTION EFFECTS FROM NUCLEAR EXPLOSIONS: A REVIEW OF DAMAGE EXPERIENCE AND PREDICTION METHODS. Holzer, Fred (California Univ., Livermore. Lawrence Radiation Lab.). 2 Jun 1971. Contract W-7405-eng-48. 24p. Dep. NTIS.

Ground motion from nuclear explosions can damage one- and two-story buildings when surface velocities are as low as 0.1 to 0.2 cm/sec, while high explosive blasting experience had previously suggested a threshold of between 5 and 10 cm/sec. Subsequent studies indicate that this damage correlates best with the average amplitude of the pseudo absolute acceleration (PSAA) in the 0.05 to 0.2 sec period range. Present data indicate a damage threshold of about 10 cm/sec^2, while at PSAA's of about 1000 cm/sec^2, damage to over half of the buildings can be expected. This damage is architectural in nature, consisting predominantly of cracked interior plaster, cracked brittle masonry walls, and damaged chimneys; about two-thirds of the Rulison damage was of this nature. The use of this damage prediction method requires the correct prediction of response spectra. The accuracy of such predictions has been greatly improved by employing frequency dependent yield and depth scaling. (auth)

44479 (UCRL–51068) OPPORTUNITIES TO MONITOR POTENTIAL DOSE TO MAN FROM NUCLEAR EXCAVATION. Schwartz, L.; Robison, W.; Anspaugh, L. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Jun 1971. Contract W-7405-eng-48. 20p. Dep. NTIS.

The opportunities for making measurements relating to potential dose from nuclear excavation projects are discussed. Internal pathways of exposure are emphasized. Typical sampling and measurement systems are discussed. Several hypothetical examples relating potential dose, concentrations along the pathway, and typical measurement capability are presented. (auth)

44480 (UCRL–51074) STATUS OF CONTAINED NUCLEAR EXPLOSIVE APPLICATIONS. Werth, Glenn C. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Jun 1971. Contract W-7405-eng-48. 32p. Dep. NTIS.

The status of contained nuclear explosive applications is reviewed. Particular emphasis is placed on new developments since the last general status report was issued in December 1970. Since the main thrust of the U. S. Plowshare Program is gas stimulation, that area is emphasized. Five other areas are discussed briefly: gas storage, oil shale, geothermal stimulation, chemical mining, and radioactive waste disposal. (auth)

Facilities and Equipment

Refer also to abstracts 44728, 44987, 45032, 45038, 45094, and 45394.

XUM

44481 (ANCR-1005) SOLID WASTE DISPOSAL METHODOLOGY STUDY. Commander, J. C. (Idaho Nuclear Corp., Idaho Falls). Jan 1971. Contract AT(10-1)-1230. 119p. Dep. NTIS.

Methods for managing nonradioactive solid wastes are reviewed. Methods judged applicable to AEC Site Contractors in general and to NRTS specifically were studied. This study provided a basis for analysis of alternative solid waste management systems, including current and past practice at NRTS; and it provides the information relative to health, safety, environmental impact and economy of operation required for selection of an optimized solid waste management system for NRTS. It was concluded that: current NRTS practice of solid waste storage and collection is acceptable; past NRTS practice of open burning of solid waste is not an acceptable process; controlled incineration is an acceptable process, but more expensive than sanitary landfilling is an acceptable solid waste disposal method; and contracting with a County agency for solid waste disposal is acceptable in the State of Idaho, and is the most cost effective option. Although the latter option appears to be the most cost effective, it is recommended that, due to advantages of convenience, control, flexibility, and safety of operation, an NRTS sanitary landfill be the selected alternative for disposal of NRTS nonradioactive solid waste. (auth)

44482 (CONF-701211-2) DESIGN AND DEVELOPMENT OF LARGE PRESSURE UNITS FOR NUCLEAR AND CHEMICAL ENGINEERING. Dimensional Principles. Labbens, R.; Bondoux, R. (Societe des Forges et Ateliers du Creusot, Paris (France)). 3 Dec 1970. 33p. (In French). Dep. NTIS (U. S. Sales Only).

From Panel on the permanence of mechanics in advanced techniques; Paris, France (3 Dec 1970).

The general problem of the safety of gas and steam pressure systems is examined and its development in the nuclear field and in chemical industry is discussed. The prevention of failures by the introduction of plasticity in the applied mechanics of solids is described and the resulting progress in the mechanics of pressure units is studied. Criticisms of the ASME code relative to nuclear facilities are given, together with probable modifications of this code. Brittleness and the development of rupture mechanics are presented. Possible applications to pressure units for nonnuclear purposes are given. (auth) (France)

44483 (CONF-710315-26) LMFBR STEAM GENERATOR DESIGN AND DEVELOPMENT. Sturiale, L. A. (Westinghouse Electric Corp., Tampa, Fla.). [1971]. 30p. Dep. NTIS.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

An LMFBR steam generator development program is being pursued that offers an approach to achieving the reliability in operation and the high availability that are essential for a commercial LMFBR steam generator. The J modular steam generator has been selected for development because it satisfies the fundamental criteria for steam generators and because it offers the potential for high availability of the heat transport system. The J modular steam generator provides features in its design to reduce downtime for maintenance, to assure predictable stable operation, and to enhance reliability through simplicity of design and fabrication. Research and development programs in support of the J modular concept are focused on the establishment of a sound base, and the resolution of known problem areas that have plagued earlier steam generators. The successful completion of the steam generator program based on the J modular concept will result in a viable steam generator with an inherent capability to remain on-line. (auth)

44484 (CONF-710512-14) ANALYTICAL INVESTIGATIONS OF COMPACT REINFORCEMENT FOR RADIAL NOZZLES IN SPHERICAL SHELLS. Gwaltney, R. C.; Corum, J. M. (Oak Ridge National Lab., Tenn.). 10 Feb 1971. 8p. (71-PVP-26). Dep. NTIS.

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

Compact reinforcement for a series of models having single nozzles radially attached to spherical shells was examined by means of finite element analyses. Parameters studied were diameter-to-thickness ratios of the nozzles, diameter-to-thickness ratios of the spherical shells, percentage of reinforcement, outside reinforcement, inside reinforcement, and balanced reinforcement (reinforcement on both the inside and outside surfaces). The loading was internal pressure. Comparisons of theoretical predictions with experimental results are presented for one reinforced model. Twelve models were analyzed to examine the effect of compact reinforcement. (auth)

44485 (JAERI-13533) LIQUID SODIUM VALVE DEVELOPMENT. 2. Origin of Failure and Its Countermeasure. Fukaya, Yoshio; Yamamoto, Ken; (and others) (Japan Atomic Energy Research Inst., Tokai). May 1969. 30p. NTIS (U. S. Sales Only).

The Sodium Mother and Daughter Test Loop System in JAERI was operated for 4300 hours in the last three years. 120 bellows seal valves were used in this loop system, and their performance was observed during the loop operation. Typical examples of failed valves are discussed and the cause of failures and the method to prevent them are reviewed. (auth) (Japan)

44486 (JAERI-13672) SERVICE DEFECTS AND FAILURES IN SODIUM LOOP SYSTEM. Fukaya, Yoshio; Yamamoto, Ken; (and others) (Japan Atomic Energy Research Inst., Tokai). Aug 1969. 45p. NTIS (U. S. Sales Only).

The Sodium Mother and Daughter Test Loop System in JAERI was operated for a total of 5000 hours. During the operation, some service defects and failures were experienced in the loop system. Detailed descriptions of the operation causes and countermeasures for each failure are given. Suitability of the operation manual and loop construction standards of the sodium loops is also discussed. (auth) (Japan)

44487 (LB/G-3026) CAPSULE RIGS FOR MATERIALS IRRADIATION IN THE SM-2 HIGH-FLUX REACTOR. Tsykanov, V. A.; Samsonov, B. V.; Timchenko, R. A.; Shulimov, V. N.; Lobanov, G. P. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from a Russian report. 22p. (CONF-691060-21). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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Experimental apparatus for use in high-flux research reactors is described. Capsule-incorporating equipment with and without temperature controls are described and their uses summarized. The use of auxiliary heaters is also described. Data are included on x-ray spectra in SM-2 core positions and on design specifications for the various capsule rigs. (J.R.D.)

44488 (LFEN-NI.-52-a) TYPES OF STEAM TURBINES FOR DUAL-PURPOSE NUCLEAR CENTERS. Production of Electrical Energy and Desalinization of Water. Leite, A. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 55p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A brief study of the types of steam turbines used in dual purpose power plants for the simultaneous production of electrical energy and desalination by multiflash evaporation is presented. The basic parameters selected for the analysis of types of turbines for use in a Portuguese pilot plant are summarized. The data necessary for the preliminary calculations are presented. A method for using these data in the selection of a turbine type is given and applied to the Portuguese case. (J.S.R.)

44489 (NYO-4117-1) DEVELOPMENT OF HIGH TEMPERATURE ROLLING BEARINGS FOR OPERATION IN LIQUID SODIUM. Quarterly Progress Report No. 1, June 15, 1970-September 30, 1970. Cocks, M. (SKF Industries, Inc., King of Prussia, Pa. Research Lab.). Contract AT(30-1)-4117. 27p. Dep. NTIS.

Activities in an exploratory study to demonstrate the feasibility of operating rolling bearings in liquid Na at 1200°F are summarized. Progress during the period is reported on design of a liquid sodium handling system and wear test equipment. Work on literature reviews and material selection is also reported. (J.R.D.)

44490 APPARATUS FOR EMBEDDING SAMPLES IN A METAL ALLOY. Lemaitre, Jacques; Quataert, Didier (to EURATOM). British Patent 1,235,800. 16 Jun 1971. Priority date 16 Dec 1968. Luxembourg.

An apparatus for preparing metallic samples for analysis by embedding in an alloy is described. The apparatus may be used in preparation of samples to be analyzed in ultrahigh vacuum. A means of heating and polishing the samples is included. (J.R.D.)

44491 PRODUCTION EXPERIENCE IN A ^{60}Co IRRADIATION PLANT FOR STERILIZATION OF DISPOSABLE MEDICAL PRODUCTS. Kendra, Edward J. (ETHICON, Inc., Somerville, N. J.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 42-7 (1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Production experience is discussed using gamma radiation from a cobalt-60 source as the method of choice for sterilization of certain disposable medical products, including surgical sutures, disposable syringes, disposable surgical gloves and glove lubricating cream. The high capital investment is offset by the low operation costs, minimal maintenance, ease of operation, and

practically no environmental pollution. The greatest advantages are the high mechanical reliability of the plant and the very high product sterilization reliability of this method. (auth)

44492 GENERALIZATION OF THE ELEMENT METHOD. Crastan, Valentin (Schweizerische Elektrizitaets- und Verkehrsgesellschaft, Basel). Nucl. Eng. Des.; 15: No. 2, 113-20(1971). (In German).

As pointed out by several papers dealing with the finite element method, the latter can be considered as a particular case of Ritz's Method, in which the parameters are the values of the field function in the nodes and the base functions attached to the nodes are other than zero only in the contiguous elements. By virtue of this equivalence the method can be applied not only to structural problems but to all problems related to a variational principle. Recently it was pointed out that the finite element method does not necessarily require the existence of a variational principle. A description is presented of how the finite element principle can directly be applied to differential equations. Several methods are possible. A method is proposed, which includes as a particular case, when the equivalent variational problem exists, the usual finite element method; examples are given. (auth)

44493 SOME GENERALIZATIONS OF THE INCREMENTAL STIFFNESS RELATIONS FOR FINITE DEFORMATIONS OF COMPRESSIBLE AND INCOMPRESSIBLE FINITE ELEMENTS. Oden, J. T.; Key, J. E. (Univ. of Alabama, Huntsville). Nucl. Eng. Des.; 15: No. 2, 121-34(1971).

General incremental forms of the equations of motion of both compressible and incompressible finite elements subjected to finite deformations are presented. These also apply to large deformations of viscoelastic materials in which increments in the histories of the deformation gradients are used. For incompressible materials, an initial pressure matrix is derived to account for variations in local hydrostatic pressure. Numerical examples are included. (auth)

44494 THREE-DIMENSIONAL THEORY ON THE NATURAL VIBRATION OF CIRCULAR CYLINDRICAL SHELLS. Ando, Yoshio; Yagawa, Genki; Kawai, Tadahiko (Tokyo Univ.). Nucl. Eng. Des.; 15: No. 2, 135-48(1971).

Using the three-dimensional theory of elasticity, a direct method of solution for the natural vibration of a circular cylindrical shell is formulated based on the principle of virtual work. A method is described in which the majority of existing theories are abandoned, and the vibration characteristics of a circular cylindrical shell with arbitrary thickness to curvature ratio are studied in a unified way. In a numerical analysis influences of the length-curvature as well as thickness-curvature ratios are extensively studied for various cases of geometrical boundary conditions. (auth)

44495 DESCRIPTION OF SOME IRRADIATION CAPSULES. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 98-108(Nov-Dec 1970). (In French).

These capsules were placed inside the Osiris vessel, either in its core (OC) or in the core periphery (OP). They were used to irradiate graphite samples. The Arcures capsules and the compact OC capsules which are provided with a water channel for internal cooling are described. The Clio and maxi-Clio capsules were designed for irradiation between 600 and 1600°C in pool-type reactors and consist of a stacking capable of being discharged from the capsule. A capsule for the measurement of creep under irradiation was developed. The Rapsodie-HT and NR capsules and the mini-Oc capsules are described. (France)

44496 CYRANO DEVICES. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 91-4(Nov-Dec 1970). (In French).

The Cyrano devices are used to irradiate fuels with high linear power. A Cyrano device is described and its performance given for the case in which the power is known and the can temperature controlled, and for the case in which the can temperature is fixed. The sample-holders allow the introduction of devices for measuring the thermal conductivity, the lengths, the fission product pressure or the fission product recovery in Siloe, Avogadro, Melusine, or BR_2. (auth)

44497 CONTINUOUS IRRADIATION CELL. Icre, Pierre; Laizier, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,031,747. 9 Nov 1970. Filed 6 Feb 1969. (In French).

The irradiation cell utilizes a beam of accelerated electrons to irradiate a continuously circulating liquid product with a controllable rate of flow. It consists of an elongated tank whose axis is perpendicular to the direction of the electron beam, coupled at both its ends to a continuous feed pipe carrying the product to be irradiated, and provided with a discharge tube for regulating the height of the liquid in the tank. This cell is used for the radiovulcanization of latex with beam energies between 2 and 10 MeV. (France)

Heat Transfer and Fluid Flow

Refer also to abstracts 44483, 45247, 46253, 46254, 46259, and 46260.

44498 (AEEW-R-683) USE OF FREON 12 TO MODEL FORCED CONVECTION BURNOUT IN WATER THE RESTRICTION ON THE SIZE OF THE MODEL. Stevens, G. F.; Macbeth, R. V. (Atomic Energy Establishment, Winfrith (England)). May 1971. 14p. Dep. NTIS (U. S. Sales Only).

From initial experimental work at the UK Atomic Energy Establishment at Winfrith, it appeared that in modeling forced convection burnout there was little restriction on the size of the model, provided dimensional similarity was maintained. Test results on uniformly heated round tubes showed that burnout in water was accurately modeled by Freon 12, even though the Freon 12 test section varied from twice the size to one quarter the size of the water test section. Since these early tests, more experimental results for annuli and multi-rod clusters with both uniform and non-uniform axial heat flux profiles have been produced at Winfrith. These results show that with the more complex geometries a restriction on physical size does appear to exist. The present report gives all the relevant experimental facts and reaches the conclusion that for universal application of the Freon modeling technique, the burnout test section in the Freon experiment must not be much smaller in size than the water channel under study. (auth) (UK)

44499 (INP-739) ON A CERTAIN FORM OF THE GENERALIZED EQUATION OF THE FLOW RESISTANCES OF HYDROMIXTURES. Korbel, K. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 8p. (In Polish). Dep. NTIS (U. S. Sales Only).

A new form of the generalized equation of the hydromixture flow resistance is proposed. The bases for generalization are the characteristic parameters: v_{rat} and I_{rat} determining the optimum (rational) conditions of hydraulic conveying of solid material. (auth)

44500 THERMAL STRESSES IN PLATES WITH CIRCULAR HOLES. Rao, K. S.; Bapu Rao, M. N.; Ariman, T. (Univ. of Notre Dame, Ind.). Nucl. Eng. Des.; 15: No. 2, 97-112(1971).

The temperature and membrane stress distribution in a finite rectangular plate with an insulated circular hole is investigated. The temperature varies along the coordinates within the plane. The temperature distribution is determined as the solution of the steady state heat conduction equation, then the membrane stresses due to the temperature are analyzed. For both steps the free edge conditions around the insulated circular hole are satisfied exactly while the boundary conditions at the outer edges of the plate are satisfied at selected points by the method of point matching. The numerical results are presented for temperature distribution and membrane stresses. (auth)

Isotope Technology

Refer also to abstracts 44403, 44404, 44491, 44564, 44587, and 44727, 46319.

44501 (BMBW-FBK-70-28) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ELECTROMAGNETIC ISOTOPE SEPARATORS AND THE TECHNIQUES OF THEIR APPLICATIONS, MARBURG, SEPTEMBER 7-10, 1970. Wagner, H.; Walcher, W. (eds.) (Marburg Univ. (West Germany). Physikalisches Institut). Dec 1970. 602p. (CONF-700944).

Fifty-one papers presented at the conference are included. They cover the following subjects: on-line separators and related problems, chemical problems connected with on-line separations, classical separation work, recoil spectrometers, ion optical problems related to electromagnetic isotope separators, ion production, collection problems, and multipurpose low energy ion accelerators. Separate abstracts were prepared for 50 papers. One paper was previously abstracted for NSA as 25: 15844. (M.C.G.)

For abstracts of individual papers see: 44401, 44402, 44404, 44410, 44502-44541, 44718-44721, 45291, and 45538.

44502 (BMBW-FBK-70-28, pp 14-43) SURVEY OF EXISTING ON-LINE SEPARATORS. Talbert, W. L. Jr. (European Organization for Nuclear Research, Geneva (Switzerland)).

From seventh international conference on electromagnetic iso-

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tope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A survey of isotope separator on-line (ISOL) systems which are in operation is presented. Emphasis is placed on the techniques employed in various systems, such as target and transport line configurations, ion source and separator types, and ion beam handling of separated beams to detector stations. The performances of existing systems are outlined in a general way for the purpose of suggesting the types of studies which are currently possible. Comments are included indicating desirable developments in isotope separation for on-line experiments. (auth)

44503 (BMBW-FBK-70-28, pp 44-8) PINGIS PROJECT. Bergstroem, I.; Fransson, K.; af Ugglas, M. (Forsvarets Forskiningsanstalt, Stockholm (Sweden)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Activities in the PINGIS Project are described. The PINGIS system employs an ion source-target assembly in which a cyclotron ion beam penetrates a Nb window in the ion source chamber to strike stacked thin foils in the discharge region. Reactions in this system are not limited to those of recoil nuclei. (J.R.D.)

44504 (BMBW-FBK-70-28, pp 49-56) ON LINE ISOTOPE SEPARATOR EXPERIMENT AT THE PRINCETON PENNSYLVANIA ACCELERATOR. Naumann, R. A.; Huebel, H.; Loeser, F.; Spejewski, E. (Princeton Univ., N. J.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An on-line isotope separator facility has been set up at the Princeton-Pennsylvania Accelerator in the external beam of 3 GeV protons at currents of 6×10^{11} protons per second. The components used are basically from a Stockholm separator including a 90° 150 centimeter radius magnet. The target, usually lead of a thickness 50 to 100 grams/cm^2, is located at the end of the proton beam line downstream from three targets used for elementary particle experiments. The target is contained in a movable, heated stainless steel container and volatile products are pumped to the ion source. The ions pass through the 3.4 meter shielding wall of the proton beam cave through a beam pipe 15 centimeters in diameter equipped at each end with electrostatic lens systems. After mass separation the desired ion beam passes to a moving tape collector equipped with semiconductor electron and gamma detectors. Initial experience and spectroscopic results from this system are reported. (auth)

44505 (BMBW-FBK-70-28, pp 57-8) OSIRIS STATUS REPORT. Borg, S. (Forsvarets Forskningsanstalt, Stockholm (Sweden)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The system for on-line separation of isotopes at a reactor in Studsvik has been in operation since June 1968. It is designed to permit studies of nongaseous and gaseous fission products with half-lives down to the expected limit for β stability (about 0.1 sec). The ion source containing the ^{235}U target is located in the immediate vicinity of the reactor core (the activity is about 5×10^{11} n/cm^2 sec at 1 MW). The beam tube contains the lens system and a coaxial tube with smaller diameter is connected to the deflector chamber providing differential pumping. After a deflection of 20° in the spherical deflector the ion beam is directed into the ISOLDE-type magnet ($r = 1.5$ m, $\phi = 55°$, $\epsilon'' = -35.5°$). Just before the magnet the beam passes a spherical lens. The dispersed beams are then intercepted by different kinds of collectors. Monitoring of the beam is accomplished by means of mechanical scanners at the entries of the deflector and the magnet, respectively, and in the collector chamber. (auth)

44506 (BMBW-FBK-70-28, pp 59-67) MODIFICATION OF THE ELECTROMAGNETIC MASS-SEPARATOR ON LINE WITH A HEAVY ION CYCLOTRON. Tarantin, N. I.; Kabachenko, A. P.; Kuznetsov, I. V.; Dyachihin, Yu. A.; Ivanov, N. S.; Om Zai Khun (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Modifications resulting in transport of a beam of reaction products out of the mass-separator cabin into a shielded room are described. Addition of a new small-size electron emitter in the ion source and changes in shape and position of the anode are also described. Reaction products identified by beta decay using the modified system include ^{8}He, ^{20}O, ^{22}F and ^{24}Ne. (J.R.D.)

44507 (BMBW-FBK-70-28, pp 68-77) ON-LINE TECHNIQUE FOR MEASURING INDEPENDENT FISSION YIELDS. Balestrini, S. J.; Forman, L.; Wolfsberg, K. (Los Alamos Scientific Lab., N. Mex.); Jeter, T. R. (Ballistic Research Labs., Aberdeen Proving Ground, Md.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The Bernas type surface ionization technique has been used to separate cesium fission products produced by an intense burst of neutrons from the Godiva IV reactor facility. Isotopes were collected along the focal surface of a broad range magnetic spectrograph. Time of collection was referenced to the reactor burst and ranged from 0.75 second to 10 seconds. After collection, the collector strip was analyzed for long-lived activity at each mass unit. A new isotope, ^{145}Cs, was observed and its fission yield was measured. Activity was also observed at mass-146; however, a cesium yield could not be determined unequivocally from the data. (auth)

44508 (BMBW-FBK-70-28, pp 78-86) EXPERIMENTAL TECHNIQUES IN USE AT THE TRISTAN ON-LINE ISOTOPE SEPARATOR SYSTEM. Talbert, W. L. Jr.; McConnell, J. R. (Ames Lab., Iowa).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The TRISTAN on-line isotope separator system at the Ames Laboratory Research Reactor has been in full operation since early in 1967. In the ensuing time, several experimental techniques have been developed to facilitate the operation of the separator and to extend the studies of short-lived nuclei made available by the system. Several of these developments are discussed including: reduction of transport time of gaseous fission products to the separator ion source by locating the fissioning sample in a neutron beam; high-sensitivity beam scanning, with acceptable sensitivities to beams of the order of 0.1 nA; high sensitivity beam position stabilization, with positive stabilization possible for beams of the order of 0.01 nA (the smallest "impurity" beam found in our separator); the use of an automatically controlled gas leak for ion source discharge support; a secondary ion-beam handling system incorporating a switching magnet; and a versatile moving tape collector used to study the decays of individual decay-chain-member nuclei. (auth)

44509 (BMBW-FBK-70-28, pp 87-98) CONDITIONING AND PERFORMANCE OF AN ON-LINE ISOTOPE SEPARATOR ASSEMBLY FOR FISSION YIELD MEASUREMENTS OF VERY SHORT-LIVED NUCLIDES. Oron, M.; Amiel, S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Methods for calculating transfer times in on-line systems for measuring short-lived nuclear reaction products are examined. An isotope separator was used in experiments directed to short-lived noble gas products produced by neutron fission of $^{235}UO_2$ stearate. Information is included on irradiation timing and mass purity. (J.R.D.)

44510 (BMBW-FBK-70-28, pp 99-103) ON-LINE ISOTOPE SEPARATOR PROJECT PROPOSED FOR LAMPF. Dropesky, B. J. (Los Alamos Scientific Lab., N. Mex.).

From seventh international conference on electromagnetic iso-

tope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An on-line isotope separator project has been proposed for the Los Alamos Meson Physics Facility (LAMPF) which is due to be completed in late 1972. Although similar to the on-line separator project at CERN, the system proposed for LAMPF aims at utilizing a fair fraction of the very intense (1 mA) 800-MeV proton beam of this linear accelerator to achieve a 100- to 1000-fold higher radionuclide production rate in the target. The objectives will be to study the properties of the shortest-lived, most neutron-deficient, spallation-produced nuclides available as well as producing substantial quantities of longer-lived nuclides for high resolution nuclear spectroscopy. Some of the difficult problems associated with targeting in such an intense proton beam, with transporting the radioactive products of interest to the ion source, and with adequately shielding the nuclear spectrometers and personnel from the high radiation levels at various parts of the system will be briefly discussed. (auth)

44511 (BMBW-FBK-70-28, pp 104-7) ISOTOPE SEPARATOR SEMI-ON-LINE WITH AN AVF CYCLOTRON. ten Brink, B. O.; Dulfer, G. H.; Verheul, H. (Vrije Universiteit, Amsterdam (Netherlands). Natuurkundig Laboratorium).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A pneumatic transport system and other handling equipment are described for a facility in which the spectroscopy laboratory is located about 50 m from the irradiation location in a cyclotron. The samples are transported in about 6 sec. The system was tested using ^{63}Zn. (J.R.D.)

44512 (BMBW-FBK-70-28, pp 108-17) ON LINE SEPARATION OF SHORT-LIVED IODINE ISOTOPES. Achterberg, E. O.; de Aisenberg, E. Y.; Iglesias, F. C.; (and others) (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The Buenos Aires ISOL is designed primarily to study short-lived fission products. The fission product generator is coupled through a 50 cm transport line to an electromagnetic separator, and a collecting device which included detectors. Operation of the system is described along with results of experiments. (J.R.D.)

44513 (BMBW-FBK-70-28, pp 118-23) RECENT RESULTS ON NEUTRON-DEFICIENT HEAVY RARE-EARTH NUCLIDES. Chu, Y. Y. (Brookhaven National Lab., Upton, N. Y.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A general approach to study of neutron-deficient nuclides with half-lives in the order of tens of minutes is described. Nuclides of rare earths such as Lu, Yb, and Tm were examined. (J.R.D.)

44514 (BMBW-FBK-70-28, pp 176-96) LARGE SCALE AND RADIOACTIVE SEPARATIONS AT THE OAK RIDGE NATIONAL LABORATORY. Love, L. O. (Oak Ridge National Lab., Tenn.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Separation of stable and radioactive isotopes during the last 25 years at ORNL is reviewed. Information is included on radioactive separations, trends in isotope usage, and production of stable isotopes. (J.R.D.)

44515 (BMBW-FBK-70-28, pp 197-202) COLLECTION OF NICKEL IN DIFFERENT METAL BACKING. Smith, H. J.; Rautenbach, W. L. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Experimental methods used in collection of $^{58}Ni^{+}$ ions on Cu and Zn substrates are described. Methods of measuring collected amounts of ^{58}Ni are discussed along with sputtering ratios. (J.R.D.)

44516 (BMBW-FBK-70-28, pp 203-8) SEPARATIONS OF LOW ABUNDANT RARE EARTH ISOTOPES. Ihle, H.; Murrenhoff, A.; Neubert, A.; Kurz, U.; Lipperts, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Rare earth nuclides of low natural abundance have been enriched by electromagnetic isotope separation. A laboratory separator of the SIDONIE-type designed at Orsay was used for this work. Methods used to obtain the optimum enhancement factors which can be attributed to the separator's physical properties are discussed. (auth)

44517 (BMBW-FBK-70-28, pp 209-12) CONTAMINATION PROCESSES DURING GAS COLLECTIONS IN MILLIGRAM QUANTITIES. Camplan, Jean; Meunier, Robert; Sarrouy, Jean-Louis (Centre National de la Recherche Scientifique, Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

SIDONIE is an isotope separator at Orsay designed for the separation of transplutonium elements. The planned transplutonium program was much delayed and during the interim period stable element separations (rubidium, xenon and mercury) were carried out to determine the best conditions for the performance of this apparatus. The main features of SIDONIE are described. Calculations which are the basis of interpretation of the contamination processes occurring during gas collections are included. (auth)

44518 (BMBW-FBK-70-28, pp 213-23) EQUIPMENT DEVELOPMENTS WHICH REDUCE SECOND-PASS NEEDS. Love, L. O.; Banic, G. M.; Bell, W. A.; Dagenhart, W. K.; Veach, A. M. (Oak Ridge National Lab., Tenn.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Information and data are presented on the 180° inhomogenous field sector isotope separator and the 540° helical isotope separator. (J.R.D.)

44519 (BMBW-FBK-70-28, pp 282-302) MULTIFIELD PARTICLE SEPARATORS. Wollnik, H. (Giessen Univ. (West Germany). Zweites Physikalisches Institut).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Particle separators usually consist of one sector field. Separators consisting of more than one sector field have rarely been built. Basic relations which determine the obtainable resolving power and particle intensity as well as a lower limit for the costs are examined. It is shown that multifield separators have large advantages over the conventional one-sector field separators. A principal design of such a system is presented. (auth)

44520 (BMBW-FBK-70-28, pp 303-30) ION EXTRACTION AND BEAM FORMATION FROM A PLASMA ION SOURCE. Chavet, I. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

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In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Relations between the extraction system in electromagnetic ion separators, the ion source, and the main beam characteristics are examined. The discussion is limited to plasma ion sources and to conditions normally found in isotope separators. (J.R.D.)

44521 (BMBW-FBK–70-28, pp 331-6) NEW ELECTRODE GEOMETRY FOR THE FORMATION OF DIVERGING IONS BEAMS IN THE PRESENCE OF SPACE CHARGE. Meunier, Robert (Centre National de la Recherche Scientifique, Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Methods of calculating radial trajectories are described for ions emitted by cylindrical plasma menisci. The effects of space charge phenomena are expressed in the equations for beam formation inside specified dihedral angles. (J.R.D.)

44522 (BMBW-FBK–70-28, pp 337-44) CARDINAL POINTS AND THE ABERRATION OF A PLANE RETARDING LENS. Bautz, P.; Brandt, B. A.; Wagner, H. (Marburg Univ. (West Germany). Physikalisches Institut).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Studies of plane retarding lenses for simultaneous z-focusing of several isotopes are described. The studies include computation of ion trajectories through the lens. Results of calculations revealed limitations for the usable opening of the lens; the maximal permissible inclination angle between lens and beam axis; and the maximal beam current which may be focused. When using strong retardation (the potential of the second lens electrode being the source potential) the focal point is positioned in a region of finite field strength at an equipotential which gives a retardation of approximately 3% of the primary energy. For lower retardation where the second lens electrode has 0.8 Φ_{source} the focal point moves farther away from the lens center in a nearly field-free region. (J.R.D.)

44523 (BMBW-FBK–70-28, pp 345-65) NUMERICAL METHOD FOR STUDYING THE OPTICS OF THE ELECTROMAGNETIC ISOTOPE SEPARATORS WITH AXIALLY SYMMETRIC MAGNETIC FIELD. Fatu, Clement; Hanganut, Marius; Jalobeanu, Mihail (Academia R.S.R., Cluj. Institutul de Fizica Atomica).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A numerical method is described for calculating the trajectory of ions moving in the median plane of the magnetic field, and based on this, the focusing properties of the machine. Mathematical modeling of the ionic beam by a large number of individual trajectories is used as the basis of a procedure proposed for the determination of the cross distribution of the ionic current density in the image (the peak form). This allows the determination of the position of the images, mass dispersion, focal angle, factors characterizing the image quality, and the resolution, for the case of an image produced by a point source if the space charge and scattering effects are neglected. Taking in consideration a complete set of constructive and functional parameters, the method can be useful especially in comparative studies and in designing of mass spectrometers or separators. (auth)

44524 (BMBW-FBK–70-28, pp 366-72) IMPROVED ION-OPTICAL GEOMETRY FOR ELECTROMAGNETIC ISOTOPE SEPARATORS. Chavet, I. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An improved ion-optical geometry is proposed which allows establishing a limited number of relatively simple optical conditions for elimination of third order aberration terms in separators of the homogeneous sector-type. (J.R.D.)

44525 (BMBW-FBK–70-28, pp 373-80) STIGMATIC FOCUSING EFFECTS IN A VARIABLE GEOMETRY ISOTOPE SEPARATOR. Freeman, J. H. (Atomic Energy Research Establishment, Harwell (England)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The use of vertical focusing produced by sector magnets for ions whose trajectories are inclined to the normals of pole faces in isotope separators is described. Magnets having variable radii and rotatable pole tips are used permitting compact designs incorporating high degrees of experimental flexibility and higher machine performance. (J.R.D.)

44526 (BMBW-FBK–70-28, pp 381-93) ISOTOPIC CONTAMINATION IN THE GRENOBLE ISOTOPE SEPARATOR. Boge, M.; Bouriant, M.; Chantereau, E.; Dousson, S.; Bouchez, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Grenoble Univ. (France). Institut des Sciences Nucleaires).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Results of studies show that the contamination factor C after the first magnet is relatively low ($\approx 10^{-3}$ to 10^{-4}) and the neutral contamination is then dominant. After the second magnet, the contamination factor is still smaller (10^{-5} to 10^{-6}). This residual effect is related to the chromatism. With a third electrostatic stage high-purity separation could be obtained; however, unfavorable conditions became evident, i.e., vacuum contamination, surface effects, and external contamination. However, it is believed that the method is useful for isotope collections of low natural abundance such as ^{204}Pb (1.37%) and ^{235}U (0.6%). (auth)

44527 (BMBW-FBK–70-28, pp 394-7) CHROMATIC ABERRATION IN ISOTOPE SEPARATORS DUE TO CHARGE EXCHANGE. Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta (India)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Charge exchange effects were examined in electromagnetic separators in which crossed beams were used. Oscillations found in the relations between charge exchange cross sections and ion energy were studied. The oscillatory structure was predicted by the impact parameter method using suitable wave functions. Results are analyzed for their usefulness in reducing contamination in isotope separators. (J.R.D.)

44528 (BMBW-FBK–70-28, pp 423-32) HOLLOW-CATHODE ION SOURCE AND ITS APPLICATION TO ON-LINE SEPARATIONS. Sidenius, G. (Niels Bohr Institutet, Copenhagen (Denmark)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Design information and data are presented for models HCIS-VI-b and HCIS-VI-i hollow-cathode ion sources. Information is included on principles of plasma formation and magnet design. (J.R.D.)

44529 (BMBW-FBK–70-28, pp 433-9) NEW CONSTRUCTION OF THE SPUTTERING ION SOURCE FOR THE ISOTOPE SEPARATION OF NON-VOLATILE ELEMENTS. Zuk, Wlodzimierz; Maczka, Dariusz (Marie Curie Sklodowska Univ., Lublin (Poland)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An ion source operating on the principle of cathode sputtering for the separation of isotopes of nonvolatile elements has been constructed. The construction of the source differs from that of other known sources in which the principle of cathode sputtering has been utilized. All parts of the source possess axial symmetry. The cathode is placed on the external side of the source so that while the source is working the electric arc covers the region of cathode sputtering as well as that of the formation of the ion beam, the regions themselves being separated. The source permits the production of stable ion currents both of the gas supporting the electric discharge and the ions of the sputtered cathode material. Using argon as supporting gas and a Cu sputtered electrode, the stable currents, measured on the electromagnetic collector of the separator after deflection of the beam in the magnetic field, were 20 μA and 5 μA respectively. (auth)

44530 (BMBW-FBK-70-28, pp 440-6) OPTIMIZATION OF ION SOURCE AND ION OPTICAL PARAMETERS FOR THE ISOTOPE SEPARATOR IN THE YASNAPP-1-FACILITY. Piotrowski, A.; Raiko, V. I.; Tyrroff, H. (Joint Inst. for Nuclear Research, Dubna (USSR)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Results of investigations aimed at optimization of ion sources and ion optical parameters for the Yasnapp-1 facility are described. Conditions which are associated with the highest resolution and best beam resolution are identified. (J.R.D.)

44531 (BMBW-FBK-70-28, pp 461-6) INFLUENCE OF OXYGEN ON THE SURFACE IONIZATION OF BARIUM ON TUNGSTEN. Mueller, R.; Wagner, H. (Marburg Univ. (West Germany). Physikalisches Institut).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Results of investigation on optimum operation of Ba surface ionization sources are presented. Parameters of Ba ion current incident on W were studied. It was found that by use of an oxygen partial pressure of about 10 μ torr and an emitter temperature of 2200°K, a Ba-ion current density of about 10 $\mu A/cm^2$ is attainable. (J.R.D.)

44532 (BMBW-FBK-70-28, pp 467-72) EXPERIMENTS WITH A NEGATIVE SURFACE IONIZATION SOURCE FOR STUDYING FISSION PRODUCED HALOGENS WITH AN ON-LINE ISOTOPE SEPARATOR. Venezia, Abraham; Amiel, Saadia (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The use of surface ionization source for on-line studies of iodine isotopes was investigated. Descriptions of experimental equipment and techniques using graphite ionizer are included. The overall yield of the iodine activity was about 10^{-4}%. The net surface ionization efficiency was found to be 10^{-2}% at 1550°C. (J.R.D.)

44533 (BMBW-FBK-70-28, pp 473-80) ION SOURCE AND BEAM-HANDLING SYSTEM USED AT ISOLDE. Sundell, S. (European Organization for Nuclear Research, Geneva (Switzerland)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A newly developed ion source at CERN is described. Experience at ISOLDE using the new source is reviewed and aspects of the beam handling system are discussed. (J.R.D.)

44534 (BMBW-FBK-70-28, pp 482-504) PREPARATION OF THIN SOURCES BY RETARDATION TECHNIQUES. Tortschanoff, T.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Methods of preparing thin radioactive sources are reviewed. Information is included on use of electromagnetic separators, use of electrostatic retardation, and variations of electrostatic retardation methods. (J.R.D.)

44535 (BMBW-FBK-70-28, pp 525-32) ELECTROSTATIC BEAM DEFLECTION AND RETARDATION COLLECTOR SYSTEM FOR A MEDIUM SIZE ELECTROMAGNETIC ISOTOPE SEPARATOR. Tortschanoff, T. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Methods for separation of neutral ions from those which can be decelerated by a retarding field in the preparation of beta sources are described. Information is included on calculation of potential, ion trajectories, and operation of deflection and deceleration collector. (J.R.D.)

44536 (BMBW-FBK-70-28, pp 534-61) LOW ENERGY HEAVY ION ACCELERATORS. Freeman, J. H. (Atomic Energy Research Establishment, Harwell (England)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A review of ion accelerators in the energy range 10 to 500 keV is presented. Only those systems which incorporate some method of beam analysis are considered. Information is included on ion sources, ion beam geometry, accelerator configurations, beam analysis, use of multiply charged ions to increase energy range, scanning requirements, target chambers, and microfused ion beams. (J.R.D.)

44537 (BMBW-FBK-70-28, pp 562-575) 40-200 kV ION ACCELERATOR WITH THREE BEAM LINES. Bannenberg, J. G.; Boerboom, A. J. H. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

An accelerator is described which consists of a sputter-ion source or a duoplasmatron with extraction electrode, Einzel lens, analyzing magnet, and associated power supplies mounted inside a metal box. A three-cylinder accelerating lens with the last cylinder at ground potential is included. The center cylinder is used to monitor a non-linear relation with the accelerating voltage to focus the beam at the mass defining diaphragm at a fixed position. A combination of an electrostatic quadrupole triplet is also included along with a second diaphragm, a three-port switch magnet, and another triplet. The two diaphragms make it possible to control beam radius and divergence (max 1°) independently. (auth)

44538 (BMBW-FBK-70-28, pp 576-83) HARWELL 150 keV HEAVY ION ACCELERATORS. Hill, K. J.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell (England)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Design and use of the Harwell heavy ion accelerators are described. Information is included on ion sources, accelerator lenses, analyzing magnets, target lines, target chambers, power supplies, and on-line facilities. (J.R.D.)

44539 (BMBW-FBK-70-28, pp 584-90) HARWELL 500 keV COCKCROFT WALTON ACCELERATOR AS MODIFIED FOR THE PRODUCTION OF HEAVY IONS. Hill, K. J.; Francis, R. J. (Atomic Energy Research Establishment, Harwell (England)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromag-

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netic isotope separators and the techniques of their applications (1970).

The 500-keV Cockcroft–Walton generator was originally used solely for neutron work. Its conversion which has permitted the production of heavy ions at high energies has considerably increased the versatility and usefulness of the machine. Modifications and uses are described. (auth)

44540 (BMBW-FBK-70-28, pp 591-5) HARWELL 80 keV HEAVY ION ACCELERATOR. Hill, K. J.; Francis, R. J.; Hayward, R. J. (Atomic Energy Research Establishment, Harwell (England)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The design and uses of the 80-keV heavy ion accelerator are described. The accelerator is used for ion implantation, to supplement on-line work, and to further development of the sputtering ion gun. The design is like that of the Cockcroft–Walton accelerator except that acceleration is provided by a single-gap lens. (J.R.D.)

44541 (BMBW-FBK-70-28, pp 596-8) INJECTOR SYSTEM AND FIRST RF ACCELERATOR OF THE UNILAC. Schmelzer, Ch. (Heidelberg Univ. (West Germany). Institut fuer Angewandte Physik. Gesellschaft fuer Schwerionenforschung, Darmstadt (West Germany)).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The UNILAC is a variable energy heavy ion linear accelerator, at present in its early phase of construction. The machine is designed to accelerate ions up to uranium at an energy range from 2 to at least 8.5 MeV/nucleon. The injector system (essentially ion source and d-c preaccelerator) and the low velocity part of the rf accelerator are described. The latter covers the fixed energy increment from 11.5 to 187 keV/nucleon. This combination is an example of a relatively economic way of producing intense beams of heavy ions at fixed, medium velocity. (auth)

44542 (COO-1422-99) SPECTRAL DIFFERENCE IN COMMERCIAL ^{125}I PHOTON SOURCES. Witt, Robert M.; Mazess, Richard B.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology). [1970]. Contract AT(11-1)-1422. 10p. Dep. NTIS.

Factors are considered that may alter the attenuation properties and the apparent spectral composition of ^{125}I photon sources used in the absorptiometric determination of bone mineral content including radionuclide contamination, induced fluorescence radiation, instrumentation shifts, and variations in the beam filtration. Since variations were observed in the thickness of the tin filters in commercially available ^{125}I photon sources, it was recommended that users be provided with a tin filter window that would be placed over the source holder. (D.H.M.)

44543 (EGG-1183-1508) LOCATING THE LOST ATHENA ROCKET IN MEXICO BY ARMS AND SUBSEQUENT SOIL ANALYSIS. Technical Report No. L-1022. Doyle, J. F.; Burson, Z. G. (EG and G, Inc., Las Vegas, Nev.). 3 Feb 1971. 30p. (CONF-710608-1). Dep. NTIS.

From Annual health physics symposium; New York, N. Y. (21 Jun 1971).

On 5 July 1970, an Athena missile was launched by the U. S. Air Force from Green River, Utah as part of a routine testing program. The missile payload contained two ^{57}Co sources, of approximately 400 mCi each. The Athena failed to operate normally and achieved an altitude three times that programmed resulting in an impact zone some 400 miles south of the United States/Mexico border. The Aerial Radiological Measuring System (ARMS) scientific team was asked to participate in the search for the ^{57}Co using the ARMS gamma radiation detection system. Subsequently, a successful search for the sources was made. Various samples were then returned to Las Vegas for analysis and identification. (auth)

44544 (MLM-1817) MOUND LABORATORY ISOTOPIC POWER FUELS PROGRAMS: JANUARY–MARCH 1971. (Mound Lab., Miamisburg, Ohio). 15 Jun 1971. Contract AT-33-1-GEN-53. 57p. Dep. NTIS.

Plutonium-238 metal and dioxides are used as fuels for heat sources. Methods of preparing the fuels are being developed, and the characteristics of the fuels are being determined. The production of plutonia–molybdenum cermet (PMC) fuel discs was continued, and the fifth Pioneer capsule was fueled. Emphasis was placed on lowering the neutron emission from the final fuel discs. To achieve this, all $^{238}PuO_2$ particles coated during the latter part of this report period were processed in the $MoCl_5$ coating system. Spherical isotopic fuel forms are being developed to meet the design requirements of the multi-hundred watt heat source program. Hot pressing techniques were investigated for preparing thoria-molybdenum and plutonia-molybdenum spheres with up to 1.5 in. diameters. Three thoria-molybdenum spheres were prepared with densities up to 95% of theoretical to test die designs and hot pressing techniques. Two 87% dense plutonia-molybdenum cermet spheres were prepared using dies developed for the ThO_2-Mo cermet sphere process. Two PMC discs (Type-3), coated with molybdenum, were tested for ambient temperature (270 to 300°C) dimensional stability for over 30 days. The results show that no significant dimensional changes have taken place. Three production grade plutonia-molybdenum cermet discs were selected from the production cycle and cut into analytical specimens for metallographic and chemical analyses. Results of these analyses are presented. Neutron emission rate measurements of three Pioneer capsules and one Transit capsule yielded an average neutron multiplication of 1.25 and 1.31, respectively. Experiments were performed on $^{238}PuO_2$ plasma-fired microspheres to determine the feasibility of reducing the helium inventory of the microspheres from SNAP-27 capsule FCA-4, without changing the impurity levels, in order that this fuel could be reused in the SNAP-27 FCA-8 capsule. Once the bakeout procedure was established, the helium inventory of SNAP-27 capsule FCA-4 was baked out and the residual helium inventory was consequently determined. A procedure was developed for treating hydrochloric acid waste solution before shipment to the recovery facility. A distillation and dechlorination technique was chosen after other more direct techniques proved unsatisfactory. This procedure is time-consuming but appears to be a satisfactory solution to this problem. Substoichiometric plutonium dioxide was found to be detrimental to platinum at 1000°C. The results of 90-day compatibility testing are presented. The addition of 4.4 wt % yttrium metal powder improved the compatibility between PuO_2 and Ta–10 wt % W alloy. The results of experiments at 1200°C for 59 and 120 days are given. An analysis was made of the possibility of oxygen embrittlement of tantalum alloys in the Transit and Pioneer capsules due to fuel decomposition. The Langmuir relationship can be used to calculate rates of oxygen absorption. In the range of 800 to 1100°C, these rates are determined to be low, particularly for substoichiometric fuel. The effects of oxygen contamination of T-111 (Ta–8 wt % W–2 wt % Hf) with up to 6,000 ppM oxygen are being investigated. The data have led to the conclusion that it is much more difficult to homogeneously contaminate T-111 alloy with oxygen than to contaminate either tantalum or Ta–10 wt % W material. It also appears that significant quantities of oxygen (3,000 ppM) can be dissolved in T-111 alloy material without appreciably impairing its mechanical properties at 2200°F. It appears that low helium permeation rates in the 1-in. dia, curved, high-temperature vent resulted from an alumina coating that was used on the vents as a protection during the final hot press. (auth)

44545 (NUMEC-4189-5) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM, Phase II. Quarterly Progress Report, February 1, 1971–April 30, 1971. (Nuclear Materials and Equipment Corp., Apollo, Pa. Energy Conversion Div.). May 1971. Contract AT(30-1)-4189. 51p. Dep. NTIS.

Progress is reported on preparations for pilot production of radioisotope powered cardiac pacemakers. These preparations are approximately 80% complete. Data are presented on the life testing of the prototype nuclear batteries and circuits which have been implanted in dogs. Methods for and results from analyzing the failure of batteries after approximately 32 unit years of operation and the failure of circuits after approximately 61 unit years of operation are described. Details of system fabrication, production development, and performance testing are reported. Finally, results are reported for a safety analysis performed to determine the optimum fuel encapsulation material under cremation conditions. Titanium appeared to be the best choice. (L.C.L.)

44546 (RLO-2225-T-20-4) UPTAKE OF BOMB ^{14}C IN THE SOUTHERN OCEANS. Fairhall, A. W.; Bradford, P.; Yang, I. C.; Young, A. W. (Washington Univ., Seattle. Dept. of Chemistry). [1971]. Contract AT(45-1)-2225. 5p. Dep. NTIS.

Water samples from the mid-latitudes in the south Pacific and from high southern latitudes were collected to study the amounts of natural and bomb-produced radiocarbon in the southern oceans. Approximately 200 60-liter water samples were collected and processed aboard the USNS Eltanin for their dissolved CO_2 content

and returned to the laboratory for ^{14}C counting. The results are presented graphically as ^{14}C specific activity as a function of depth at several locations. It is concluded that the Arctic Circumpolar Water is characterized by ^{14}C levels of around −150‰. Ice cover during most of the year and the low-salinity layer in summer inhibit air-sea exchange over the Ross Sea so that very low levels of ^{14}C were found even in the surface layer. By contrast, vigorous air-sea exchange of CO_2 occurred at mid-latitudes as evidenced by the significant enrichment of bomb ^{14}C in the upper layers. In some areas bomb ^{14}C enriched the surface layer by nearly 200‰. (L.C.L.)

44547 URANIUM ENRICHMENT ACTIVITIES IN ITALY. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 60-2(Oct 1970). (In Italian). (CONF-700903-9).

From fourth Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden (21 Sep 1970).

The enrichment activities by the CNEN and industry in Italy are briefly summarized. (J.S.R.)

44548 HIGH SPEED CENTRIFUGAL SEPARATOR. (to Mitsubishi Jukogyo Kabushiki Kaisha). French Patent 2,001,976. 3 Oct 1969. Priority date 15 Feb 1968, Japan. (In French).

This invention is concerned with a centrifugal separator that consists of a compartment with a single-piece rotor mounted inside. An application of the invention is the separation of the isotopes uranium-235 and uranium-238. (auth)

44549 URANIUM ENRICHMENT BATTLE. Soum, Jean-Claude. Sci. Avenir; No. 290, 313-17; 342(Apr 1971). (In French).

Two important decisions were taken by France: the enlisting of help from U.S.S.R. for the enrichment (75 tons necessary for the Fessenheim plant start up) and development of studies necessary for the construction of a civil enrichment plant with a large capacity. A test facility was constructed for testing the enrichment stages of this plant which has a power of 3.000 kW. Gaseous diffusion successfully used at Pierrelatte was proposed by the CEA for the isotopic separation process, but further studies on an ultracentrifuge prototype are being developed. (France)

44550 APPLICATIONS OF RADIOISOTOPES. NUCLEAR ENGINEERING. PART XXII. Symposium Held in Chicago, November 30–December 1, 1970. Meyer, L. H. (ed.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 1-106(1970). (CONF-701131).

Thirteen papers were presented at the conference. A separate abstract was prepared for each. (R.C.K.)

For abstracts of individual papers see: 44351, 44491, and 44551–44561.

44551 SOLVING PROCESS ENGINEERING PROBLEMS WITH RADIOTRACERS: MASS TRANSFER. Fries, Bernard A. (Chevron Research Co., Richmond, Calif.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 1-6(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Measurement of the transfer of liquid, gases, and solids in processing industries can be made with radioactive isotopes as tracers. Diverse applications include mass flow rates, flow patterns, leaks, and residence times. These provide information useful for process control. Wider application to process design is suggested. (auth)

44552 ^{60}CO FOR HEAT AND POWER. Mirshak, S.; Ross, C. P.; Whatley, V. (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 7-15 (1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Cobalt-60 can provide reasonably priced heat or power for many remote applications and has a half-life (5.24 yr) that makes it readily manageable for ultimate disposal. These properties together with developed heat source technology are now being incorporated into a first generation ^{60}Co device for operation in the multiwatt range. The AEC has started a ^{60}Co loan program to encourage other demonstrations of thermal applications, and the Savannah River Laboratory is providing data on performance and safety of encapsulated ^{60}Co at heat source temperatures. (auth)

44553 ^{60}Co HEAT SOURCE APPLICATION. Kim, C. (Westinghouse Electric Corp., Pittsburgh). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 16-31(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Man's ever increasing activities in remote locations and difficult environments, such as the antarctic and underseas, have created a need for a new type of power supply for the operation of equipment and instrumentations. The logistic problems associated with fuel supply for these remote locations suggest a radioisotopic power system. A conceptual design of a large cobalt-60 heat source for terrestrial application is presented, as well as a conceptual design of a small cobalt-60-fueled power system for undersea applications. (auth)

44554 APPLICATIONS OF RADIOISOTOPES TO INDUSTRIAL AND AEROSPACE MEASUREMENTS. Jernigan, E. D. (Industrial Nucleonics Corp., Columbus, Ohio). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 32-41(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Many applications have been discovered for the use of radioisotopes in industry. Radioisotope techniques have particularly found widespread acceptance in the area of continuous on-line analytical instrumentation and process control. Thousands of process control systems, utilizing these techniques, are in use today throughout the world, controlling such things as thickness of material, weight per unit length of material, density, fill level, composition, and plating of materials. These systems are in use in the rubber metals, paper, tobacco, plastics, food, and chemical industries. During the past 20 yr, sizable sums of money have been spent in research and development to improve and expand radioisotope applications in industry. Within the past few years technology has been finding more and more application in areas of federal interest such as the aerospace programs. The techniques that were developed for industrial applications are described, and their usefulness in federal applications, as well as some that have evolved the other way around, is discussed. (auth)

44555 APPLICATIONS OF PORTABLE RADIOISOTOPE X-RAY ANALYZERS IN INDUSTRY AND MINING. Rhodes, John R. (Columbia Scientific Research Inst., Austin, Tex.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 48-57(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Portable radioisotope x-ray fluorescence analyzers are battery operated instruments weighing about 15 lb that are in use for elemental analysis of ores, alloys, process solutions, and slurries in industry and mining. They can perform rapid, quantitative determinations of any preselected element from calcium to plutonium, in the concentration range 0.1 to 100%. (auth)

44556 USE OF RADIOISOTOPES ARTIFICIAL HEART DEVICES. Hastings, Frank W.; Harmison, Lowell T. (National Heart and Lung Inst., Bethesda, Md.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 58-61(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

The Artificial Heart Program has been developing totally implanted energy systems for artificial heart devices. One such energy system would utilize radioisotopic energy to drive the artificial heart devices. Many problems related to insulation, volume, weight, reliability, efficiency, and biological effectiveness are discussed, and the technological advances to date are described. Other problems associated with such development programs and requirements for solution are also described. (auth)

44557 PROTOTYPE $^{244}Cm_2O_3$ HEAT SOURCE. Robinson, R. A. (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 62-8(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Approximately 400 g of $^{244}Cm_2O_3$ has been hot pressed into the form of fourteen cylindrical pellets and encapsulated in a tungsten capsule. The fueled capsule has been assembled into a tungsten foil insulated test bed and is operating at 1,300°C to simulate the operating conditions in a radioisotope-fueled energy conversion system. The fabrication and assembly procedures and the design of the fuel capsule are discussed. (auth)

44558 PROPERTIES OF ISOTOPIC α,n AND γ,n NEUTRON SOURCES. Downs, W. E. (Atomic Energy of Canada Ltd., Ottawa). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 69-73 (1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Methods of production and the final physical form of the more promising α,n and γ,n sources ($^{241}Am-Be$, $^{238}Pu-Be$, $^{241}Am-Be-^{242}Cm$, $^{124}Sb-Be$) are described. A brief comparison of operating costs based on useful neutron output and handling problems is given. Properties which could affect a source's usefulness in industry, that is, size, γ output, neutron energy, and half-life, are discussed, along with commercial availability. (auth)

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44559 PREPARATION AND PROPERTIES OF ^{252}Cf NEUTRON SOURCES. Reinig, W. C. E. I. du Pont de Nemours and Co., Aiken, S. C.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 74-80(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Californium-252, a relatively new neutron source, is potentially valuable in research, medicine, and industry primarily because of its intense emission rate of 2.34×10^{12} neutrons/sec/g. Methods were developed to prepare ^{252}Cf sources for use in cancer therapy, neutron radiography, process control instruments, and exploration for natural resources. (auth)

44560 USE OF ^{252}Cf AS A NEUTRON SOURCE FOR WELL LOGGING. Paap, H. J.; Scott, H. D. (Texaco, Inc., Bellaire, Tex.). Contract AT(38-1)-540. Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 88-90(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

A major goal of the well logging industry is the identification of potential oil producing horizons in the earth formations surrounding a borehole. Neutron logs are used to determine porosity, salinity, and the presence of gas. Improvements and new techniques possible with higher intensity of ^{252}Cf neutron sources are discussed. (auth)

44561 RADIOISOTOPE SOURCES AND NEUTRON RADIOGRAPHY. Barton, J. P. (Argonne National Lab., Ill.). Chem. Eng. Progr., Symp. Ser.; 66: No. 106, 91-106(1970).

From Symposium on the applications of radioisotopes; Chicago, Ill. (Nov-Dec 1970). See CONF-701131.

Objects such as reactor fuel elements, explosive detonators, and aircraft components are routinely examined by radiography using neutrons from nuclear reactors. Neutron radiography facilities now being established for routine application work use small accelerators that yield about 10^{10} n/sec. Moderate quality neutron radiographs can also be obtained with isotopic sources, and applications will exist for radiographing thin objects, especially where an inexpensive on-site facility is needed. The elements of small source neutron radiography are described, the techniques are compared with reactor source neutron radiography, and the capabilities of the available isotopes are analyzed. Results of work with $^{210}Po-Be$, $^{239}Pu-Be$, $^{241}Am-Be$, $^{241}Am-^{242}Cm-Be$, $^{244}Cm-Be$, $^{124}Sb-Be$, and ^{252}Cf are also discussed. (auth)

Materials Testing

Refer also to abstracts 44485, 44486, 44489, 44993, 45007, 45070, 45887, and 46256.

44562 (BNWL-SA-3147) ACOUSTIC EMISSION APPLIED TO DETERMINATION OF STRUCTURAL INTEGRITY. Hutton, Philip H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. 31p. (CONF-700442-1). Dep. NTIS.

From eleventh open meeting of the mechanical failures prevention group; Williamsburg, Va. (7 Apr 1970).

Acoustic emission is defined as the elastic waves produced in a solid material by energy released as the material is deformed or fractured. These waves can be detected at the surface of the material with high sensitivity transducers. This provides the basis for a new technique for monitoring metal structures, pipes, pressure vessels, graphite shapes, etc., to detect structural deterioration before failure occurs. Flaw detection resolution using acoustic emission exceeds that of any of the conventional nondestructive techniques such as ultrasonics, radiography, etc. It is, however, limited to detection of an active strain or flaw area — it will not detect static flaws. The development work conducted at Battelle-Northwest to apply acoustic emission to detect flaw growth in nuclear reactor pressure systems, formation of cracks in welds, metal fatigue, and thermally-induced cracking in ceramics is discussed. (auth)

44563 (EUR-4341) DETERMINATION OF THE SIZE AND POSITION OF DEFECTS IN SPHERICAL GRAPHITE FUEL ELEMENTS USING ULTRASONIC TESTING. Boehlo, D.; Floeder, H.; Hoffmann, D. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 15p. (In German). NTIS (U. S. Sales Only).

The difficulties lie essentially in the limitations of the test frequencies and heads available. The fixed geometry of the spheres influences the size of the measuring head and thus the maximum wave-length and hence the minimum test frequency. The validity of the ultrasonic test is dependent essentially on the grain size of the spheres being tested. The larger the grain the less valid the indication of any possible defects at the same frequency, i.e., at the moment a good indication of defect sizes can be obtained only from the study of graphite types with a fine-grained structure, e.g., 2239 PP produced by Carbone Lorraine. (auth)

44564 RADIOGRAPHIC INSPECTION OF AIRCRAFT FUSELAGE BY USING A ^{170}Tm GAMMA SOURCE. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst., Takasaki. Takasaki Radiation Chemistry Research Establishment, Japan); Enomoto, Shigemasa; Maeda, Sho; Doi, Tatsuo; Nakamura, Shinji. Hihakai Kensa; 20: No. 3, 121-6(Mar 1971). (In Japanese).

Aircraft fuselages have been routinely inspected by nondestructive methods including conventional x-ray radiography. However, there are several parts whose inspection is almost impossible or difficult by any method without disassembly of fuselage structures. ^{170}Tm γ-ray radiography was used on trial to examine the possibility of defect or trouble detection in these cases. The test was carried out on the selected parts of Douglas DC-8-type fuselage using a 21 Ci ^{170}Tm γ-ray source, 3 mm diameter and 3 mm length. In advance of the test, characteristic features of ^{170}Tm γ-ray radiography for aluminum alloy were experimentally studied. Most of the radiographs obtained in the fuselage inspection showed fairly good radiographic definition, and it appears that the method can be adopted in the maintenance work. For practical use of this method, the activity of the ^{170}Tm γ-ray source should be increased to reduce the working time with the appropriate radiographic condition. (auth) (Japan)

Radioactive Material Handling

Refer also to abstracts 44480, 44511, and 45109.

44565 (DPSPU-71-124-3) SAFETY SUMMARY REPORT: PM-3A-M CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Langhaar, J. W.; Scaggs, R. A. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jun 1971. Contract AT(07-2)-1. 111p. Dep. NTIS.

Spent PM-3A reactor cores, type II or IV, are shipped in modified PM-3A casks in compliance with the US and international regulations for safe transport of radioactive and fissile materials. As a result of this safety evaluation showing compliance, a license amendment and DOT Special Permit No. 6478 were issued, reproductions of which are included. (auth)

44566 (GAMD-8894) STRUCTURAL AND THERMAL ANALYSES OF THE PEACH BOTTOM SINGLE ELEMENT SHIPPING CASK LICENSING. Buttemer, D. R.; Petersen, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). 4 Jul 1971. Contract AT(04-3)-314. 135p. Dep. NTIS.

The Peach Bottom spent fuel element shipping cask is described along with modifications to satisfy the requirements of Federal Regulation 10-CFR-71, "Packaging of Radioactive Materials for Transport." The cascading-hypothetical-accident series of standard transport conditions may be demonstrated either by test or by calculation. The calculations carried out and submitted to the AEC for approval of the cask are presented. Included are calculations pertaining to the structural and thermal analyses done on the cask to demonstrate its compliance with the requirements of 10-CFR-71. The results are discussed. (auth)

44567 (IN-1465) SAFETY ANALYSIS REPORT FOR PEACH BOTTOM I CORE 1 FUEL STORAGE FACILITY. Hammond, J. D.; P'Pool, R. S.; Modrow, R. D. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 39p. Dep. NTIS.

A dry fuel storage facility has been constructed at the Idaho Chemical Processing Plant (ICPP) for storage of the Peach Bottom I Core 1 fuel. The facility consists of 47 underground storage vaults, each capable of storing a shipment of 18 Peach Bottom elements. Results of analysis are presented which show that the facility is safe for storing the fuel. The facility is designed to provide nuclearly safe storage under maximum reactivity conditions. Handling procedures and equipment permit placement of the fuel in storage with minimal radiation exposure to personnel, and the sealed vaults and fuel canisters provide adequate fuel containment for long-term storage. The design basis accident is defined as a handling accident in which the fuel basket support system fails during the vault loading operation. This would expose the lower unfueled portion of the fuel elements. However, even for this case, direct exposure of personnel to the fueled portion of the elements would not occur and radiation exposure would be limited to minor doses initially, and some controlled doses during corrective operations. Thus, it is concluded that even this maximum credible accident for the facility does not present unacceptable hazards. (auth)

44568 (LA-4686) SHIELDED SHIPPING CONTAINER FOR FISSILE MATERIAL CLASS I OR LARGE QUANTITIES OF RADIOACTIVE MATERIAL. Noyes, Horace E. (Los Alamos Scientific Lab., N. Mex.). Jun 1971. Contract W-7405-eng-36. 51p. Dep. NTIS.

A small, well-shielded shipping container was designed to accommodate whole or sectioned irradiated fast reactor fuel elements and associated hardware and components in compliance with existing regulatory requirements. Background material and approvals are included. (auth)

44569 (ORNL-TM-3348) RECEIPT AND ANALYSIS OF THE CONSOLIDATED EDISON URANIUM PRODUCT SOLUTION, AND SUBSEQUENT STORAGE UTILIZING SOLUBLE NEUTRON ABSORBERS. Parrott, J. R.; Nicol, R. G.; Nichols, J. P. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 81p. Dep. NTIS.

The engineering feasibility of handling and storing large volumes of fissile solution, using soluble neutron absorbers for criticality control, is being tested at ORNL. An aqueous nitrate solution of the purified uranium product (1047 kg of uranium containing 76.5% ^{235}U, 9.7% ^{233}U, 6% ^{238}U, 1 to 4% ^{234}U, and 0.01% ^{232}U) from the Consolidated Edison Indian Point Reactor was received in 524 bottles (24 shipments) and is being stored in a single 5,000-gal tank at a concentration of 100 to 200 g/liter; soluble cadmium and gadolinium are being utilized for criticality control. The differences in the weights of uranium, ^{235}U, and ^{233}U as measured by the Nuclear Fuels Services Plant and ORNL were less than 1% for the total quantities received. No serious problems with the use of soluble neutron absorbers for criticality control have occurred after storage for approximately two years. The concentrations of uranium and neutron poisons have remained stable. One unanticipated problem, caused by the formation of radioactive daughters of ^{220}Rn gas in the vapor space of the storage tank (and the subsequent deposition of these nuclides in unshielded off-gas piping), was resolved by installing a de-entrainment device and a shielded absolute filter near the tank. (auth)

44570 (UCRL-51044) USE OF A DEEP NUCLEAR CHIMNEY FOR THE IN-SITU INCORPORATION OF NUCLEAR FUEL-REPROCESSING WASTE IN MOLTEN SILICATE ROCK. Cohen, Jerry J.; Lewis, Arthur E.; Braun, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.). 4 May 1971. Contract W-7405-eng-48. 25p. Dep. NTIS.

A method for disposing of nuclear-reactor wastes by in-situ incorporation in molten silicate rock is presented. In this method, liquid wastes are injected into a deep underground chimney and allowed to self-boil. The resulting steam is processed at the ground surface and recycled into a closed system. When waste addition is terminated, the chimney is allowed to boil dry, thereby solidifying the waste. The heat generated by the radioactive waste then melts the surrounding rock, which dissolves the waste. Finally, the rock refreezes, trapping the radioactivity in an insoluble rock matrix deep underground. This method has significant environmental and economic advantages over previously proposed methods. (auth)

44571 (WASH-1168) INCINERATION OF RADIOACTIVE SOLID WASTES. (Atomic Energy Commission, Washington, D. C.). Aug 1970. 151p. Dep. NTIS.

Incineration was investigated as a method for handling combustible radioactive solid waste, particularly those wastes from AEC sites. Literature on incineration, incinerators, and off-gas cleaning was reviewed. Experiences with incinerating both nonradioactive and radioactive solid wastes were studied. The quantity of combustible radioactive solid wastes generated annually at AEC sites was estimated. It is concluded, based on cost, safety, need, and availability of usable equipment and methods, that research and development for incinerating radioactive wastes at AEC facilities can be justified at this time. (L.C.L.)

44572 (Y-DD-100) METHODS USED TO CALCULATE PACKAGE CRITICALITY SAFETY. Mee, W. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 14 Jul 1971. Contract W-7405-eng-26. 13p. (CONF-710801-1). Dep. NTIS.

From third international symposium on packaging and transportation of radioactive materials; Richland, Wash. (16 Aug 1971).

Methods used to analyze the criticality safety of packages for shipping fissile material must satisfy both technical and economic criteria. The primary technical criterion to be satisfied is that a method must be validated for its proposed use. For numerous reasons, not the least of which are the conditions of package environment which must be assumed in analyses according to USAEC and IAEA transport regulations, such a validation may be a complicated procedure. Economic criteria which must be satisfied can be the most difficult to establish because of the complex interrelationships between the costs of analysis, packing, and transportation. Several methods of analysis in current use, including solid angle, NB^3_N, and transport theory calculations, are used to satisfy these criteria. Examples of the various methods are delineated. Transport indices for the examples were calculated, and some are presented in graphical rather than tabular form to allow for increased flexibility in using the packages. (auth)

44573 HANDLING AND TRANSPORT OF IRRADIATED FUEL. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 92-7(Oct 1970). (In Italian). (CONF-700903-13).

From fourth Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden (21 Sep 1970).

The experience gained in Italy on the handling and transport of irradiated fuel is summarized. The technical aspects of the transport of radioactive materials, such as container tests, are considered. (J.S.R.)

44574 CYLINDRICAL CASK. Brisac, Michel (to Omnium Technique de Mecanique). French Patent 2,038,664. 28 Dec 1970. Filed 21 Mar 1969. (In French).

This cylindrical cask for the transport of radioactive products contains a fixed body consisting of a cylindrical axial bore giving access to a cavity in the body. The cavity has a volume possessing a symmetry of revolution about an axis perpendicular to that of the bore and a movable part oscillating about the axis of symmetry. (France)

44575 AUTOMATIC PACKAGING PROCESS FOR RADIATION SOURCES. Fradin, Jean; Lengagne, Paul (to Commissariat a l'Energie Atomique). French Patent 2,038,451. 28 Dec 1970. Filed 7 Mar 1969. (In French).

In this automatic process for packaging radiation sources, a circular plate provided with equidistant peripheral holes passes automatically and periodically, in a shielded enclosure, in front of a series of equidistant operation units distributed around the circumference corresponding to various processes in the packaging. A logic circuit determines for each of the holes, from information about the preceding operation unit, when to put their particular unit into operation. (France)

44576 RECHTSPROBLEME DER BESEITIGUNG RADIOAKTIVER ABFAELLE IN DAS MEER. EINE VOELKERRECHTLICHE UND RECHTSVERGLEICHENDE UNTERSUCHUNG. (Legal Problems in the Disposal of Radioactive Wastes in the Sea. An International Legal and Comparative Law Investigation). Pelzer, Norbert. Studien zum Internationalen Wirtschaftsrecht und Atomenergierecht. Band 41. (Studies of International Economic Laws and Atomic Energy Laws. Volume 41). Goettingen, Ger.; Institut fuer Voelkerrecht (1970). 278p.

The first section discusses economic and scientific problems, disposal of radioactive waste in the sea from the standpoint of national and international law, and the definition of radioactive contamination of the sea. The second part discusses permissibility of radioactive waste disposal in the sea in accordance with international law: high sea, agreement about high sea, other international agreements, territorial waters, and continental shelf. The third part discusses permissibility of radioactive waste disposal in the sea in accordance with international law for USA, Great Britain, and other countries. The fourth part discusses problems and basic trends for future agreements. It is concluded that development should proceed in three phases: intensive scientific study of waste disposal, preliminary international agreement with limited duration, final comprehensive international agreement about regulation of radioactive waste disposal in the sea. (H.B.G.)

44577 DISPOSAL OF LIQUID WASTES INTO COASTAL WATERS. Templeton, W. L. (Battelle Memorial Inst., Richland, Wash.). Effluent Water Treat. J.; 11: No. 5, 251-8(May 1971).

Methods employed to assess the risks posed by radioactive waste disposal are discussed and their application to monitor the effects of other pollutants, such as pesticides, is considered. Special reference is made to the Windscale and Bradwell nuclear power station sites. (UK)

44578 TREATMENT AND DISPOSAL OF RADIOACTIVE AND OBJECTIONABLE SOLID WASTES. Pearce, K. W. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Ind. (London); No. 22, 590-2(29 May 1971).

A description is given of methods used at Harwell for dealing with solid waste. Details are given of solid waste categories, sludge handling, sea disposal, and decontamination of equipment. (UK)

44579 PACKAGING OF URANIUM HEXAFLUORIDE FOR TRANSPORT. ANSI N14.1 1971. New York; American National

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Standards Institute (1971). 51p. Available from American National Standards Institute, New York.

This standard provides criteria for packaging of UF_6 for transport. Specific information on design, fabrication, inspection, cleanliness, and in-service requirements for the UF_6 packaging is included. Also included are cylinder loadings, shipping details, and requirements for valves and valve protectors. (auth)

44580 REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Safety Series No. 6 1967. Vienna; International Atomic Energy Agency (1967). 117p. (STI/PUB-148). Available from UNIPUB, Inc., New York.

An up-to-date edition of the IAEA regulations for the safe transport of radioactive materials by land, sea and air is presented. In addition to the developments on packaging design and testing and on nuclear safety criteria published in the 1964 revised edition, it incorporates new detailed provisions for the transport of large radioactive sources. A few other amendments have also been made. The regulations also include limitation of external dose rate, general accident provisions, storage and carriage, labels and placards; tables give classification of radioisotopes, flux equivalents, safe distances and separations, maximum permissible contamination levels, etc. The regulations were prepared with the aid of panels of experts and representatives of international organizations and should facilitate the acceptance of packages by the authorities concerned. Further revision is not envisaged for a few years. (auth)

Vacuum Engineering

44581 (KHFTI-70-24) CALIBRATION OF MANOMETERS UP TO 10^{-15}mm MERCURY WITH THE AID OF AN IDEAL DIFFUSION PUMP. Grishin, S. F.; Grishina, E. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

A technique for calibrating manometers is discussed which is based upon the vapor pressure of a saturated vapor of a substance. Hydrogen was selected for calibrating the simple apparatus described, and a graph of pressure vs 1/T is supplied. A magnetron manometer was calibrated down to 10^{-15} mm Hg. The basic design of the manometer includes a vacuum chamber positioned in a Dewar flask containing liquid helium. Provision is made for an inleakage of the calibrating hydrogen gas into the vacuum chamber, which also contains the heart of the manometer—an anode and an ion collector. Pumping on the helium gas above the liquid helium lowers the temperature of the latter and consequently that of the inner vacuum chamber, and its pressure. The P vs 1/T chart referred to above is then employed to ascertain the resulting pressure in the system. (K.S.W.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 44312 and 44376.

General Detectors and Monitors

Refer also to abstracts 44734, 44735, 44794, 44801, 45583, 45857, 45991, 46021, 46056, and 46057.

44582 (BNWL-B-54) HIGH ENERGY GAMMA RAY DETECTOR WITH A FAST, VARIABLE DISCRIMINATOR. Shipler, D. B.; Sheen, E. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. Contract AT(45-1)-1830. 17p. Dep. NTIS.

A high energy (5–10 MeV) gamma ray detector with a variable, fast discriminator was developed. The discriminator circuitry employs a variably biased tunnel diode monostable multivibrator and is housed in a case mounted to the base of the photomultiplier tube for portability. The scintillation detector is designed to operate in a wide spectrum gamma field of about 200 mR/hr. The signal is taken from the PM tube anode with the low energy background field acting as a constant current and the high energy pulses superimposed. The signal from the discriminator is fed to a standard rate meter for evaluation. The detector was used successfully to measure high energy gammas streaming from the face and in the working areas of two production reactors operated by Douglas United Nuclear, Inc. From the data, calculations were made to estimate the exposure problems in these areas due to high energy gammas. (auth)

44583 (KFK-1355) FAST DETECTOR FOR SURVEY OF THE THERMAL NEUTRON FLUX PROFILE IN THE FR2 ISOTOPE CHANNELS. Schuelken, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Sep 1970. 32p. (In German). Dep. NTIS (U. S. Sales Only).

A directly indicating method of measurement is described for scanning neutron flux density profiles along the FR2 isotope channels. The measurement probe used was a neutron Compton detector with a cobalt emitter manufactured by AB Atomenergi. The practical transient time constant of the measuring circuit is $\tau_e < 0.7$ sec. Profile scannings over a height of 2, 5 m are possible in 6 minutes. The neutron sensitivity of the detector is determined by calibration measurements with cobalt activation probes. This sensitivity corresponds fairly well with the result of theoretical treatments. The fraction of core gamma radiation in the measured signal is some 1.4% in FR2. (auth)

44584 (NYO-844-84, pp 57-9) DEVELOPMENT OF A POSITION-SENSITIVE PROPORTIONAL COUNTER. Ritter, Charles (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

A historical survey of the development of position-sensitive proportional counters is presented, and development work at Carnegie–Mellon University is outlined. (W.H.K.)

44585 (NYO-3086-10(Vol.2), pp II.1-31) PROTOTYPE RADON SURVEY METER. Bhargava, Vijay; Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine).

From Radioactivity studies.

A prototype radon survey meter for on-the-spot monitoring of radon in uranium mines has been developed. With this instrument the effectiveness of ventilation in protecting uranium mine workers can be more rapidly evaluated. The detector is sensitive primarily to the alpha emissions of radon which are detected by analysis of pulses from a photomultiplier tube covered with a ZnS layer. Interference by radon daughter alpha emissions is minimized by electrostatically collecting the positively charged daughters outside the sensitive volume. The detector response is 20 cpm/100 pCi/l, and is linear between 5 pCi per liter and 3000 pCi per liter. Accurate, immediate radon concentrations are measured when the detector is taken from low levels to high levels of radon. The reverse is not true when going from high to low concentrations by an order of magnitude because of some build-up of daughter activity in the ZnS lining. The study of such build-up shows that roughly 12% negative or neutral RaA might be formed initially upon the decay of radon. (auth)

44586 (SWRHL-501-r) ENVIRONMENTAL MONITORING SYSTEM FOR NUCLEAR TESTS. Carter, Melvin W.; Wruble, Donald T.; Jaquish, Richard E. (Western Environmental Research Lab., Las Vegas, Nev.). [Apr 1971]. 21p. (CONF-710705-3). Dep. NTIS.

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

The extensive environmental monitoring system maintained by the Western Environmental Research Laboratory for nuclear testing programs in the United States is designed to produce comprehensive information and data on radioactive contamination and exposures as quickly as possible. This is accomplished through use of aircraft and mobile ground monitoring teams that can make radiation measurements and collect a variety of environmental samples, followed by specially designed laboratory analytical procedures and data processing to expedite data acquisition. The system can thereby provide rapid assessment of radioactive releases that may affect a large segment of the population within the western United States. The information is then used to evaluate both short-term and long-term environmental and public health implications of the releases. Pertinent information and data are made available to various official state and other agencies, and provisions are made to effect protective measures if these should be deemed necessary or desirable. (auth)

44587 (UCRL-51049) HAZARDS CONTROL INSTRUMENT CALIBRATION FACILITY. Boggs, J. V. (California Univ., Livermore. Lawrence Radiation Lab.). 6 May 1971. Contract W-7405-eng-48. 15p. Dep. NTIS.

A neutron and gamma irradiation facility for calibrating health physics survey detectors is described. A 90 Ci cesium-137 source, a 0.5 Ci cobalt-60 source, and a 32 μg californium-252 source are used. Safety features are described. (W.H.K.)

44588 OBLIQUE-STAGE MICROSCOPE FOR VISUAL TRACK COUNTING IN MEDICINE. Kraus, W.; Pooch, K. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis; 6: 377-8 (Oct 1970). (In German).

The design features of an oblique-stage microscope for visual counting of α tracks in autoradiograms are described. (auth)

44589 DEVICES FOR DETECTING NUCLEAR RADIATIONS. Kozlov, Stanislav Fedorovich (to Fizichesky Institut Imeni P.N. Lebedeva). British Patent 1,238,745. 7 Jul 1971. Priority date 11 Sep 1968, Russia.

The design of a type IIa diamond crystal detector is described. (W.H.K.)

44590 NUCLEAR RADIATION DETECTORS AND DEVICE. Kozlov, Stanislav Fedorovich (to Fizichesky Institut Imeni P.N. Lebedeva). British Patent 1,238,839. 14 Jul 1971. Priority date 20 Sep 1968, Russia.

A type IIa diamond crystal detector with a high detection efficiency for low-energy radiation which can operate in a corrosive media is described. (W.H.K.)

44591 RADIATION DETECTOR. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,239,255. 14 Jul 1971. Priority date 9 Oct 1967, France.

A position-sensitive crystal detector is described. The detector utilizes two or more electrodes on the collector resistance layer to determine position. (W.H.K.)

44592 HUMAN COUNTER FOR MASS MONITORING. Shiojiri, Takamasa; Asayama, Yukio; Hino, Norio; Tokunaga, Shoichi; Iwata, Minoru (Fujitsu Ltd., Tokyo). FAPIG (Tokyo); No. 59, 212-16(Nov 1970). (In Japanese).

An economical whole-body counter for mass monitoring has been developed. It can detect and measure in a short time the internal contamination of persons who work in facilities using radioisotopes, and it is easily operated and maintained. This counter has a NaI(Tl) scintillator 5 inches in diameter and 4 inches thick. The bed can be shifted either automatically or by hand. The scanning speed and movable distance of the bed are 45 mm/sec and 2100 mm respectively. Scintillator-bed distance can be set to 2 steps of 300 mm and 400 mm. Units utilizing a dual channel pulse height analyzer, 400 channel pulse height analyzer, 400 channel pulse height analyzer and a small size computer combined, and an on-line data processor unit are available. The detection limit of this counter is 2.5×10^{-2} μCi, 2.7×10^{-3} μCi, and 3.2×10^{-3} μCi for ^{40}K, ^{60}Co, and ^{137}Cs respectively. (Japan)

44593 NEUTRON FLUENCE MEASUREMENT WITH URANIUM- OR THORIUM-DOPED FISSION TRACK DETECTOR. Yoo, Young Soo (Atomic Energy Research Inst., Seoul). New Phys. (S. Korea); 11: No. 1, 1-6(Mar 1971).

A neutron detector which consists of a phosphate glass doped with a fissile material such as natural uranium (UO_2) or thorium (ThO_2) is described. Fission fragment tracks registered in the

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glass were etched by sodium hydroxide and counted under an optical microscope with a magnification of about 420. The detector was exposed to Pu–Be standard neutron sources and thermal neutrons in a graphite pile for calibration. The registration efficiency as a function of etching concentration, temperature of etching solution, and etching time was also studied. For each parameter, an optimum time for etching in NaOH of 20 percent concentration by weight was found to be 20 minutes at 60°C for U-doped FTD and 10 minutes at the same condition for Th-doped FTD. The sensitivities of U-doped FTD for fast and thermal neutrons were found to be respectively, 0.48×10^{-6}(±1.9%) and 2.35×10^{-6}(±1.4%) fission fragment tracks/neutron, and that of Th-doped FTD for fast neutron was 0.32×10^{-6}(±3.2%) tracks/neutron. (auth)

44594 DEPENDENCE OF THE LIGHT OUTPUT OF LIQUID SCINTILLATION SYSTEMS ON THE SPECTRAL PROPERTIES OF THE COMPONENTS. Fodor-Csanyi, Piroska; Inzelt, Gyoergy (Eoetvoes Lorand Univ., Budapest). Magy. Kem. Foly.; 77: No. 3, 156-9(Mar 1971). (In Hungarian).

It is concluded on the basis of data reported in the literature that the spectral characteristics (absorption and emission bands) of the components of liquid scintillation systems (solvents, scintillators, shifters, diluters, quenchers, additive materials, etc.) decisively influence the light output of the systems. These properties are discussed. In the case of good scintillator-solvent pairs, the absorption bands of the solvent and scintillator overlap, or they are very close to each other. The absorption bands of shifters are in the emission range of the scintillators. Diluters absorb usually in a range of shorter wave-lengths than solvents. The absorption range of additive materials which increase the light output overlaps the bands of the diluters, solvents and scintillators. The absorption bands of quenchers are usually within the absorption range of solvents or scintillators. These facts can be explained by attaching a greater importance to radiation energy transfer than assumed heretofore. (auth)

44595 GEOMETRICAL CORRECTION OF ANGULAR CORRELATION COEFFICIENTS. Hourany, E. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods; 94: No. 3, 401-12(1971). (In French).

A Monte-Carlo calculation of geometrical correction factors for angular correlation is described. Coaxial Ge(Li) detectors and gamma rays in the energy range 30 keV to 1 MeV are considered. The source is taken punctual or extended. In the latter case, general features of the correction factors are given. Simulated and simplified models are presented. The validity of the simplified models is checked in several experimental conditions. (auth)

44596 IONS PRODUCED BY A STRAIGHT CHANNEL MULTIPLIER. Andresen, R. D.; Page, D. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). Nucl. Instrum. Methods; 94: No. 3, 429-33(1971).

A straight channel multiplier, activated by photoelectrons or beta electrons from a radioactive material, can be used to provide sufficient electron current to ionize neutral gas molecules. Experimental results are presented dealing with the number and type of ions produced inside the tube using "air", hydrogen, and helium as residual gas molecules. Advantages of such a source over a thermionic emitter include appreciable decrease in power consumption, reduced outgassing, no getter effect, more rugged construction, and high-frequency modulation capability of the electron beam. A straight channel multiplier used as an ion source, therefore, would be well suited to calibration work and space flight instrumentation. (auth)

44597 CONVENIENT CALIBRATION TECHNIQUE FOR NEUTRON DETECTORS. Chastel, A.; Davis, M. B.; Hoffman, C. M.; Kreisler, M. N.; Smith, A. J. S. (Princeton Univ., N. J.). Nucl. Instrum. Methods; 94: No. 3, 493-6(1971).

A method of measuring the value and energy dependence of the detection efficiency of neutron detectors is described. Results are presented for both plastic and liquid scintillators at neutron kinetic energies between 2.5 and 19 MeV. (auth)

44598 NEW PROPORTIONAL COUNTER ANODE UNIT. Cairns, J. A.; Holloway, D. F. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 94: No. 3, 579(1971).

This new device incorporates a proportional counter anode wire in a convenient unit. It permits wires to be easily interchanged and inspected, besides exhibiting very good X-ray energy resolution. (auth)

44599 DEAD TIME GENERATOR FOR LIQUID SCINTILLATION COUNTING SYSTEM. Laney, Barton H. (to Nuclear-Chicago Corp.). U. S. Patent 3,585,388. 15 Jun 1971. Filed 8 Nov 1968.

A combined coincidence and dead time signal generator incorporated in a liquid scintillation counting system employing pulse height analysis is described. Coincidence amplifiers are constructed to have dead time at least as great as that of pulse height analysis channels at any setting. Dead time of coincidence amplifiers is detected and signaled by an arrangement of logic and timing circuits. The dead time signal controls a timing circuit and coincidence function to provide live time operation of the system. (auth)

44600 STATE OF PLASMA IN SEMICONDUCTOR COUNTERS FOR STRONGLY IONIZING RADIATIONS. Ryvkin, S. M.; Strokan, N. B.; Tisnek, N. I.; Eremin, V. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 9, 1496-9(Mar 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 9, 1745-9(Sep 1970).

The influence of the state of an electron-hole plasma in the track of a nuclear particle on the formation of a pulse was determined by investigating the behavior of the pulse amplitude in a magnetic field which compressed the plasma in the tracks. The results of the experiments carried out on dE/dx-type silicon counters (lithium-drifted n–i–p structures) demonstrated the existence of a critical electric field E_{cr}: Below this value the charge losses in a compressed track increased rapidly with decreasing E. It was also found that track "erosion" in strong electric fields was due to the excape of carriers mainly from the lateral (cylindrical) surface of the track. (auth)

44601 RADIATION DETECTION AND IMAGING MACHINE. Bramlet, Roland C. U. S. Patent 3,585,387. 15 Jun 1871. Filed 1 Aug 1968.

An apparatus for detecting and for producing an observable image of radiation emitted from a source which includes a rotatable collimator interposed between a detector and the source is described. In operation, the collimater is rotated during exposure to the source. A preferred detector is a crystal that translates radiation into an optical signal. (auth)

44602 DEVELOPMENT OF A RADON MONITORING SYSTEM AND ITS USE TO STUDY TURBULENT DIFFUSION IN THE LOWER 1000 FEET OF THE ATMOSPHERE. Krablin, Richard. Philadelphia; Drexel Inst. of Tech. (1971). 141p. University Microfilms Order No. 71-15,576.

Thesis.

A two filter radon monitoring system was designed and constructed for continuous and automatic operation. The system sampled air from a fixed tower at four levels, 20, 200, 570, and 890 feet. Wind velocities and temperatures were also measured at 40, 100, 200, 350, 570, and 890 feet. The tower is situated in rolling, suburban terrain in northwest Philadelphia, Pennsylvania. The radon measurements were made every hour for four months. The average uncertainty was seven per cent, with a sensitivity of 8×10^{-15} Ci l^{-1}. The system was thoroughly tested and proved reliable. Calibration was accomplished by a simple procedure of comparison to a known source. Averages by hour of the day for each month are presented and discussed. A wind directional dependence was noted and explained as a probable result of the proximity of the Atlantic Ocean. Exhalation rates of radon from the earth are calculated from concentration profiles and compared to published values. A theory of a power law for the height dependence of the turbulent diffusion coefficient for radon, K_z, is presented, with solutions given for the time independent diffusion equations. The observed radon profiles are compared to theory with good agreement for cases of neutral and stable lapse rates, with exponents 0.82 and 0.50, respectively. Magnitudes of K_z are calculated as 10^2 and 10^{-3} m^2 sec^{-1} at one meter, for the neutral and stable lapse rates. Wind profiles for the neutral and stable cases are predicted by a power law for K_m, the eddy viscosity, with the same exponents as the K_z case. A discussion is given of the ratio k_m/K_z. (Diss. Abstr. Int., B)

44603 PROCEEDINGS OF THE INTERNATIONAL TOPICAL CONFERENCE ON NUCLEAR TRACK REGISTRATION IN INSULATING SOLIDS AND APPLICATIONS, HELD AT CLERMONT-FERRAND, FRANCE, MAY 6–9, 1969. VOLUME I. Isabelle, D.; Monnin, M. (eds.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). 418p. (In French and English). (CONF-690522-(Vol.1)).

Separate abstracts were prepared for 34 of the 36 papers presented. The remaining papers were previously included in NSA as 24: 42780 and 23: 48495. (W.H.K.)

For abstracts of individual papers see: 44604–44636 and 44693.

44604 STABILITY OF LATENT TRACKS IN MICA. Widell, C.-O. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp I.24-7 of Proceedings of the International Topical Conference on Nu-

clear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

Latent tracks of fission fragments in muscovite mica are very stable. In order to investigate this stability, irradiated mica foils were placed for different lengths of time in different temperatures. It was found that the critical time for the disappearance of the tracks could be given by the expression: $t = 10^{-15} \exp(2.8/kT)$ where k is the Boltzmann constant and T is the absolute temperature. (auth) (France)

44605 DISCRIMINATION OF HEAVY PARTICLES IN PHOSPHATE GLASS AND MUSCOVITE MICA. Perelygin, V. P.; Tretyakova, S. P.; Shadieva, N. H.; Cieslak, E. (Joint Inst. for Nuclear Research, Dubna, USSR). pp I.28-40 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

Methods of selective annealing and weak etching for the discrimination of charged particle tracks in phosphate glass and mica were developed. Phosphate glass and mica were used to study the fission of the uranium nucleus, induced by ^{16}O, ^{20}Ne, ^{40}Ar, ^{40}Ca ions, and the formation of the compound nucleus in the reaction of ^{20}Ne with Ni nuclei. (auth) (France)

44606 STUDY OF MUSCOVITE MICA IRRADIATED BY ARGON IONS, BY X RAY SCATTERING AT SMALL ANGLES. Lambert, M. (Paris Univ., Orsay, France); Levelut, A. M.; Maurette, M.; Heckman, H. pp I.41-58 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522(Vol.1).

X ray scattering measurements showed that in mica high energy argon ions produce point defects and large perturbed regions which play an important part in track formation by chemical etching. The electron density of these regions is similar to that of nonirradiated mica. They consist of a large number of defects grouped in a small region and are produced only when the particle energy loss per unit length is sufficiently high. An increase of temperature changes completely the state of the sample. (France)

44607 LATENT TRACK FORMATION IN ORGANIC NUCLEAR CHARGED PARTICLE TRACK DETECTORS. Benton, E. V. (Naval Radiological Defense Lab., San Francisco). pp II.2-27 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

The interaction of radiations with a polymer and subsequent events can be chronologically divided into three periods: energy absorption establishment of thermal equilibrium, and the establishment of chemical equilibrium. The ability to predict which particles will produce latent (etchable) tracks in a given polymeric system is a basic requirement to the practical utilization of the detectors. The parameters which influence track etching can be separated into five broad categories: the material parameters, the particle parameters, the irradiation environmental parameter, the pre-etch storage parameters, and the etching parameters. All of them are briefly reviewed. (France)

44608 FORMATION OF THE PARTICLE TRACKS. Katz, Robert; Kobetich, E. J. (Univ. of Nebraska, Lincoln). pp II.28-45 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

The formation of particle tracks, and such phenomena as the detection of charged particles and the damage produced by charged particles, are intimately related to the spatial distribution of ionization energy deposited by delta rays. Changes in the spectrum of delta rays with the velocity of the primary particle imply that linear measures of the interaction of the primary particle with the medium, such as specific energy loss, or primary ionization, are unsatisfactory measures of effects produced in the medium, for they contain no knowledge of the spatial deposition of the lost energy. (auth) (France)

44609 SOME STUDIES ON THE CHEMICAL DAMAGE MECHANISM ALONG CHARGED PARTICLE TRACKS IN POLYMERS. Johnson, D. R.; Boyett, R. H.; Becker, K. (Oak Ridge National Lab., Tenn.). pp II.46-72 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

A number of experimental studies have been carried out to obtain more information on the chemical damage mechanism along the tracks of charged particles of relatively low LET observed in the more sensitive organic plastics. For example, G-values for free radical production have been measured under different conditions using a radical scavenging technique. Infrared spectroscopy and gas chromatography have been used for qualitative and quantitative analysis of low molecular weight end products of radiolysis as a function of several parameters and the stability of latent alpha particle tracks has been measured at elevated temperatures. The effect of different agents (influence of oxygen partial pressure during exposure, humidity, H_2O_2 and ultraviolet pre- and postirradiation treatment) on the track registration threshold and/or etching kinetics of cellulose nitrate and acetate has also been examined. The possible interpretation of the results is discussed briefly. (auth) (France)

44610 TRACK FORMATION MECHANISM IN POLYMERS. Monnin, M. (Univ., Clermont-Ferrand, France). pp II.73-82 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

The chemical changes produced by the irradiation of polymers result from ionization and electron excitation. The energy dissipated by the particle along its trajectory was determined. Two processes are involved: direct action of the particle leading to excitation and ionization, and the action of the secondary electrons produced. (auth) (France)

44611 COMMENT ON EXISTING PHYSICAL CRITERIA FOR ION TRACK REGISTRATION IN POLYMERS. Paretzke, H. G.; Burger, G. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg). pp II.83-94 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

It has been shown that there are severe discrepancies in the present delta ray criteria and the primary ionization criterion. Although it is possible, within the scope of all criteria, to fit most of the known experimental data, many of their physical assumptions are not satisfying and have to be revised in several points. (France)

44612 ENHANCEMENT OF TRACK ETCHING BY A SPARK DISCHARGE. Blanford, G. E. Jr; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). pp II.95-101 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522–(Vol.1).

It was found that the rate of track etching of heavy-ion tracks in Lexan polycarbonate is greatly increased when the track-

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containing plastics are stored in a container in which a spark-discharge is occurring. A series of simple experiments, using a Tesla coil as the spark source, that have led to the opinion that the effect is caused by the interaction of excited gas species with the stored tracks is described. It does not appear to be caused either by a direct electrical effect of the discharge or by light given off by the spark. This new effect can potentially be used as a method to both sensitize and stabilize plastics containing charged particle tracks. (auth) (France)

44613 EFFECTS OF O_2, SO_2, NO, AND N_2O ON TRACK REGISTRATION. Chave, A.; Monnin, M. (Univ., Clermont-Ferrand, France). pp II.102-7 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

The effect of gases on track registration in polymers is important. Oxygen impedes cross-linking and favours degradation. The reactions in the presence of oxygen are reversible, and irreversible in the presence of sulfurous acid. (France)

44614 SOME RECENT ADVANCES IN PLASTIC DETECTORS. Enge, W. (Univ., Kiel); Momo, L. R.; Filz, R. C. pp II.108-13 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Some of the more interesting applications of plastic detectors involve nuclei of low Z, for which cellulose nitrate is particularly suitable. Heretofore, its use has been limited by the nonuniformity of commercially available sheet. This problem was overcome by the addition of certain metal-organic compounds and a casting solvent effect on sensitivity was obtained. By this means, an adjustment of sensitivity to a preferred range of Z is possible, and it now seems feasible to make a reliable discrimination between ^{9}Be and ^{10}Be. This difficult measurement can be greatly facilitated by use of the Nomarski system of differential interference microscopy. (auth) (France)

44615 PROTON TRACKS IN PLASTIC DETECTORS. Beaujean, R. (Univ., Kiel). pp II.114-18 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

An important characteristic of plastic detectors is the fact that they register higher charged particles even in the presence of high electron and proton fluxes. Measurements were performed with 0.5 to 1.7 MeV protons to study which proton densities influence the registration of higher charged particles. The measurements showed that the damaging effects of single protons in the plastic sheet can be added. Under certain conditions accumulated protons which cannot be registered at the same energy as single particles, produce etchable tracks. A disturbing track background is produced by 1.5 MeV protons at densities above 10^{11} protons per cm^2. The effect of track forming by accumulated single protons allows to study the track forming mechanism and the critical energy loss in different plastic materials. The number of etchable tracks depends on the flux and energy of the protons, the critical energy loss of the material, and the radius of the etchable damaged region. (auth) (France)

44616 STUDY OF THE TRACK REGISTRATION IN THE REGION OF THE CRITICAL ENERGY. Beaujean, R.; Meyerbroeker, H.; Enge, W. (Univ., Kiel). pp II.119-26 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

A latent track in a plastic detector can be etched to a visible track if the ratio of the track etching rate v_t to the bulk etching rate v_b is greater than 1. The etching rate in a specific material for a given particle depends on the particle's energy. For a given particle the critical energy E_c is defined by $v_t(E_c) = v_b$. The track etching rate approaches the bulk etching rate near the critical energy in an asymptotic manner. The critical energy of cellulose nitrate was determined by using vertical incident alpha particles. The relation of the track diameter, the etching time and the energy of the particle can be calculated using the track and the bulk etching rate. In the region $E \geq 3$ MeV the curve $v_t(E)$ was unknown. For this calculation $v_t(E)$ was set to be $v_t = v_b$ for $E \geq 5$ MeV and as E decreases to 3 MeV $v_t(E)$ increases to $v_t(3\ MeV) = 2v_b$. Comparing the measured and the calculated curves the critical energy of alpha particles in cellulose nitrate was found to be higher than 5 MeV. The calculation predicts that the curves of track diameters as function of the etching time using the energy as parameter are parallel to each other as E increases beyond E_c. The measured curves are not parallel up to 6 or 7 MeV. The function $v_t(E)$ can be obtained by fitting the calculated curves to the measurements. (auth) (France)

44617 INTERESTING TRACK DETECTOR: POLYVINYL CHLORIDES. Monnin, M.; Sanzelle, S. (Univ., Clermont-Ferrand, France). pp II.127-31 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Polyvinyl chloride is a very sensitive polymer since it registers alpha particle tracks. Its great advantage is to separate very clearly, in time, different ion tracks. (France)

44618 STUDIES OF ENVIRONMENTAL EFFECTS UPON TRACK ETCHING RATES IN CHARGED PARTICLE-IRRADIATED POLYCARBONATE FILM. De Sorbo, W.; Humphrey, J. S. Jr. (General Electric Co., Schenectady, N. Y.). pp II.132-5 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Wide variations in the effects of environmental gases and uv upon the track registration characteristics of the polycarbonate detector were observed. These results cannot be interpreted at this time within the framework of any responsible scheme of plausible chemical reactions. (France)

44619 SENSITIVITY ENHANCEMENT OF PLASTIC NUCLEAR TRACK DETECTORS THROUGH PHOTO-OXIDATION. Henke, R. P. (Naval Radiological Defense Lab., San Francisco); Benton, E. V.; Heckman, H. H. pp II.136-48 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

A new method is presented for the sensitization of plastic track detectors. It has been found effective for cellulosics, polycarbonates, and polyesters. Most of the reported data deals with Lexan. The method consists of irradiating plastics with ultraviolet radiation in the presence of oxygen. The sensitivity enhancement is found to increase exponentially with decreasing uv wavelength and increasing particle restricted energy loss rate, REL. This technique can be used to provide a continuously variable sensitivity from sample to sample, within a given sample, or from one etch to the next of a given sample. Greater spatial resolution is possible because of the increase in the ratio r_T/r_B. Better charge resolution is possible because of the stronger dependence of the track etch rate, r_T, on REL. Long term measurements show that samples stored in the dark in an O_2 atmosphere show a small increase in r_T with time. In inert atmospheres a negligible increase is observed, and in a vacuum r_T decreases. (auth) (France)

44620 TRACK REVEALING AND VISUALIZATION. Medveczky, L. (Magyar Tudomanyos Akademia Atommag Kutato Intezete, Debrecen, Hungary). pp III.2-13 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-

Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Procedures suitable for rendering tracks visible with an optical microscope are presented. Methods facilitating the observation of the tracks with a microscope and their visualization by other means are discussed. (37 references) (France)

44621 STUDY OF THE TRACK STRUCTURE OF HEAVY IONS IN CELLULOSE NITRATE BY ELECTRON MICROSCOPY. Tripier, J.; Debeauvais, M.; Stein, R.; Ralarosy, J.; Remy, G. (CNRS, Strasbourg). pp III.14-23 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Different heavy ion tracks were investigated with an electron microscope. The variation of the track diameter with the time, the concentration, and the energy loss was studied. (France)

44622 TRACK VISUALIZATION WITH SOLVENTS. Sanzelle, S.; Monnin, M. (Univ., Clermont-Ferrand, France). pp III.24-6 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Several plastics, and particularly methyl polymethacrylate, were studied. After irradiation the samples were immersed in ethanol at 70°C during 1.5 min. Then they were treated by boiling water during 30 sec. The results of these experiments are given. (France)

44623 TRACK ETCHING PARAMETERS FOR PLASTICS. Blanford, G. E. Jr.; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). pp III.27-41 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

A series of experiments was performed to study the effect of types of etchant, concentration of etchant, etchant temperature and other parameters on track development in cellulose nitrate, polycarbonate resin, cellulose tri-acetate, and cellulose acetate butyrate plastic. This work has led to a set of preferred etching conditions for each of these plastics. For example, although there were only slight differences in general etching rate when LiOH, KOH, and NaOH were used as track etchants for cellulose nitrate the alpha particle registration sensitivity was greatest when NaOH was used. Also in cellulose nitrate the general etching rate and the particle registration sensitivity did not change significantly with increasing concentration for hydroxide solutions >6 normal. This was in marked contrast to other plastics which showed a strong concentration dependence. (auth) (France)

44624 ENHANCEMENT OF TRACK ETCHING BY A SPARK DISCHARGE. Blanford, G. E. Jr.; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). pp III.42-45 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

An interesting effect has been observed in the development of charged particle tracks in Lexan polycarbonate. The rate of track etching is greatly increased when the irradiated plastic is stored in a container with a spark-discharge. Several simple experiments indicated that chemical species formed by the spark-discharge react with the damage sites caused by the charged particle. The effect of this reaction is to increase the hydrolysis rate of the plastic material along the track. The experiments which lead to these conclusions are discussed and some of the experiments which have been done or are being planned to specify the chemical causing track etching enhancement are mentioned. (auth) (France)

44625 AUTOMATIC OPTICAL REGISTRATION AND COMPUTER ANALYSIS OF ETCHED ION-TRACKS IN POLYMER FOILS. Abmayr, W.; Gruenauer, F.; Burger, G. (Gesellschaft fuer Strahlenforschung MBH., Neuherberg, Ger.). pp III.46-55 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

The improvement of the ion track registration technique in insulating solids requires the development of suitable methods for automatic track analysis. The basic idea of the method discussed is to digitalize the electronic information obtained from a microscopic pattern by an optical scanning device, and to feed it into a computer. Then, it is possible to perform every desirable pattern analysis by suitable programming. This method of software analysis is evidently most efficient when on-line techniques can be used. (auth) (France)

44626 STATISTICAL STUDY OF α PARTICLE TRACK COUNTING IN CELLULOSE NITRATE. Anno, Jacques, (Univ., Toulouse); Blanc, Daniel; Teyssier, J.-L. pp III. 56–65 of Proceedings of the International Topical Conference on Nuclear track Registration in Insulating Solids and Applications, Held at Clermont–Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont–Ferrand, France; Universite de Clermont–Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont–Ferrand, France (6 May 1969). See CONF-690522-(Vol. 1).

Cellulose nitrate was irradiated with 2.7 MeV alpha particles in air at normal temperature. The detector total registration efficiency lies between 90 and 100%. The maximum registration angle in relation to the perpendicular to the detector surface is 65°. (France)

44627 IMPROVEMENTS OF TRACK VISUALIZATION BY USING AN INTERFERENCE CONTRAST METHOD. Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp III.66-72 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

For the purpose of solid-state dosimetry, when no geometrical analysis of nuclear tracks is necessary, the interference contrast equipment shows several advantages for nuclear track counting including a brilliant relief image of etch pits, a good discrimination of the etch pits to the background, and the possibility to improve the contrast by changing the color of the image. Color slides demonstrate different applications of track counting by means of the interference contrast method including nuclear track counting of fission fragments in phosphate glass and mica and alpha particles in plastic foils. (auth) (France)

44628 RAPID READING TECHNIQUE FOR NUCLEAR PARTICLE DAMAGE TRACKS IN THIN FOILS. Cross, W. G.; Tommasino, L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp III.73-85 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France- Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

The low background of damage track detectors allows them to measure low integrated fluxes of charged particles or neutrons. When good statistical accuracy is desired, the long times required for visual track counting under the microscope may seriously limit the number of measurements, particularly when the track density is low. A technique has been developed for automatically counting etched tracks that pass through a thin film. Very simple and inexpensive equipment is required. The insulating film is placed between a plane, high-voltage electrode

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and a thin layer of Al. A spark, passing through the film along a damage track, evaporates a hole in the Al. A second spark is prevented from starting through the same hole, so that the discharge passes successively along each track and then stops. Sparks are counted with a scaler. The pattern of holes in the Al provides a visible replica of the pattern of tracks. Track densities from background level to 3000 tracks/cm^2 can be measured. Areas up to 100 cm^2 are usually counted in less than 10 seconds, with an error of a few percent in the number of tracks. The technique has been applied to neutron dosimetry and to measurements of angular distributions in photofission. (auth) (France)

44629 INFLUENCE OF ETCHING PARAMETERS ON THE SENSITIVITY OF PLASTICS. Somogyi, G. (Magyar Tudomanyos Akademia Atommag Kutato Intezete, Debrecen, Hungary); Medveczky, L.; Varnagy, M. pp III.86-99 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

It seems that the critical rate of primary ionization for the track registration must depend on the etching conditions, too. Simple experimental methods are presented to show a possible change in the registration sensitivity as a function of the chemical parameters. It was proved from the investigations of alpha tracks, that the sensitivity of a cellulose acetate detector can considerably depend on the concentration and sort of etching reagent. Quantitative data are given on the ratio of the rate of chemical etching along the track and on the detector surface as a function of concentration of solution NaOH for tracks of fission fragments registrated in plastics of cellulose acetate, polycarbonate, and polytherephthalate. (auth) (France)

44630 EVALUATION OF THE SPATIAL PARAMETERS K AND α IN EQUATIONS FOR FISSION TRACK URANIUM ANALYSIS. Kleeman, J. D.; Lovering, J. F. (Australian National Univ., Canberra). pp III.100–113 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont–Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont–Ferrand, France; Universite de Clermont–Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont–Ferrand, France (6 May 1969). See CONF-690522-(Vol. 1).

The equations describing fission track densities registered in solid state detectors contain some spatial parameters whose values are not well known. The product of K, a geometric factor approximately equal to the range of fission fragments in a solid, and α, the etching efficiency, is determined by simultaneously producing fission tracks from a glass of known uranium content, and monitoring the thermal neutron dose using gold foil. For tracks recorded in Lexan plastic and produced by aluminosilicate glass the value of this product is 8.1 (±13%) $\cdot 10^{-4}$ cm, and for tracks etched in the glass matrix itself it is 3.7 (±8%) $\cdot 10^{-4}$ cm. This value is compared with analogous values calculated from other published data, and by speculating on the value of α for Lexan plastic, an estimate of K is made. (auth) (France)

44631 PARTICLE IDENTIFICATION BY DIELECTRIC TRACK DETECTORS. Price, P. B.; Fleischer, R. L. (General Electric Co., Schenectady, N. Y.). pp IV.2-34 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Chemical reactivity along the trajectory of a charged particle in a dielectric solid depends on the density of radiation damaged species. In inorganic crystals such as are found in meteorites, cosmic rays can be identified by etching for a long time and measuring the entire etchable ranges of the slowing particles, which are related to their atomic numbers. In plastics and glasses the etching rate is an increasing function of radiation damage density. Measurements of etched cone lengths at different points along the trajectory of a particle that passes through several sheets provide a very sensitive measure of atomic number. In favorable cases it is possible even to resolve isotopes with the same atomic number. Some unpublished experimental details that are useful in achieving high resolution and some new, unpublished measurements are given. (auth) (France)

44632 DIAMETER OF ETCHED FISSION FRAGMENT TRACKS IN SOLID STATE NUCLEAR TRACT DETECTORS AS A FUNCTION OF THE PARTICLE ENERGY. Fiedler, G.; Hoeppner, U. (Univ., Giessen, Ger.). pp IV.35-9 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Application, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Glass and several plastic materials have been vertically irradiated by fission fragments of known mass and energy. A correlation between fragment energy and the diameters of the etched fragment tracks is given. For sufficiently long etching times the method is well capable of an energy resolution of 3 to 5 MeV. A weak mass dependence of this effect exists. To test the method, a ^{252}Cf-fission fragment energy distribution has been measured which is in good agreement with corresponding solid state surface barrier detector data. (auth) (France)

44633 SOME ANNEALING CHARACTERISTICS OF HEAVY ION TRACKS IN SILICATE MINERALS. Maurette, M. (Washington Univ., St. Louis). pp IV.40-51 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

The thermal annealing of fossil tracks stored in hypersthene crystals of the Johnstown meteorite was studied. The annealing of the tracks depends on their initial length and therefore of the charge of the incident ions. The shortest tracks are annealed at a lower temperature than the longer ones. These long tracks in turn have been found to be less thermally stable on the average than fission fragment tracks. Some difficulties in the study of the annealing of heavy ion tracks in solids were pointed out and the possibility of a thermal annealing experiment to identify the origins of the tracks stored in naturally or artificially irradiated silicate minerals, is discussed. (auth) (France)

44634 PRELIMINARY RESULTS OF MEASUREMENTS ON TRACKS OF HEAVY COSMIC RAYS IN PLASTIC DETECTORS. Enge, W. (Univ., Kiel); Bartholoma, K. P.; Fukui, K.; Filz, R. C. pp IV.52-7 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

A stack of 30 plastic sheets (18,250 μ thick and four 125 μ thick Zelux-polycarbonate sheets and eight 250 μ thick Daicel cellulose nitrate sheets) was flown in 1.5 g/cm^2 altitude for 10 hours from Fort Churchill, Canada. 8% of the area was covered on both sides by 600 μ thick Ilford G5 emulsions. The goal was to measure the charge spectrum and flux of all particles stopping within the stack, i.e. from Ne-ions of 110 to 190 MeV/Nuc up to Fe-ions of 180 to 320 MeV/Nuc, of all relativistic particles of $Z \geq 32$ in cellulose nitrate and of all relativistic particles of $Z \geq 55$ in Zelux. The charge of the particle can be determined by measuring its primary ionization rate as a function of its residual range in the plastic sheets. The calibration of this method is achieved for lower charges (Ne and Ar) by ions of accelerators and for higher charges by heavy primaries penetrating the emulsions and the plastic sheets. Furthermore the critical energy at higher charges can be measured. Two 10 × 15 cm^2 pieces of 30 plastic sheets have been etched. In one of the pieces 40 stopping particles were found and analyzed in the plastic sheets and the emulsions. This method as well as preliminary results are discussed. (auth) (France)

44635 CHARGED PARTICLE DISCRIMINATION BY TRACK MEASUREMENT. Magdalena, E. (Univ., Clermont-Ferrand, France). pp IV.73-80 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Different tracks made by different particles in two identical samples developed in the same conditions of time, concentration, and temperature, were observed. The aim of this study was the control of the validity of the delta electron theory. (France)

44636 MEASUREMENT OF CONE LENGTH AND RANGE IN ETCHED PLASTICS. O'Ceallaigh, C.; Daly, J. (Dublin Inst. for Advanced Studies). pp IV.81-91 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

Two methods are presented and described for measuring the apparent depth of a cone-tip below the extinction point for the surface corresponding to the base of the cone. (W.H.K.)

44637 PROCEEDINGS OF THE INTERNATIONAL TOPICAL CONFERENCE ON NUCLEAR TRACK REGISTRATION IN INSULATING SOLIDS AND APPLICATIONS, HELD AT CLERMONT-FERRAND, FRANCE, MAY 6–9, 1969. VOLUME 2. Isabelle, D.; Monnin, M. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). 424p. (In French and English). (CONF-690522-(Vol.2)).

Separate abstracts were prepared for 38 of the 39 papers presented. The remaining paper was previously included in NSA as 23: 48457. (W.H.K.)

For abstracts of individual papers see: 44340–44342, 44449, 44450, 44461, 44638–44657, 44705, 44794, 45163–45166, 45857, 45991, and 46054–46057.

44638 APPLICATIONS OF THE TRACK ETCHING PROCESS IN RADIATION PROTECTION. Becker, K. (Oak Ridge National Lab., Tenn.). pp V.2-31 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A brief review of the more important developments in the application of track etching techniques in health physics, in particular neutron dosimetry, is given; and some previously unpublished recent results from the author's laboratory are summarized. Two methods for fast, automatic counting of alpha particle track densities in polymers are described. One is based on a flying-spot scanner, the other on a jumping-spark technique similar to the Cross method for fission fragment counting. They greatly simplify the practical application of the etching method in fast neutron dosimetry via recoil reactions (further data on dosimetric properties are given), and radon and radon daughter product personnel dosimetry for uranium miners (detector prototypes with and without forced air circulation are described). Examples of other applications of the jumping-spark counter in health physics include imaging and quantitative determination of fissile material distributions in organic samples (for instance by neutron-induced autoradiography of bone counting ^{239}Pu), and simplified measurement of fissile materials in urine, air, etc. (auth) (France)

44639 PRELIMINARY REPORT ON THE MONITORING OF HIGHLY IONIZING CHARGED PARTICLES ABOARD APPOLO VIII. Benton, E. V. (Naval Radiological Defense Lab., San Francisco); Henke, R. P.; Richmond, R. G. pp V.32-40 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Each of the nine passive dosimetry packets worn by the crew of Apollo VIII contained two 190 micron layers of Lexan polycarbonate plastic. The plastics served as threshold type, heavy charged particle track detectors. Upon recovery the detectors were first sensitized using the recently discovered photo-oxidation technique, and then etched to reveal tracks of particles whose restricted energy loss rate exceeded 2.10^3 MeV cm^2/g. A flight average of about 1 tr/cm^2 was observed. In tracing tracks through from one layer to the next it is possible to say whether a particle stops in the plastic, determine the sense and direction of travel, and in many cases make estimates of Z to ±1 unit of charge. All the particles observed had a charge in excess of 10, and 30% came to rest in the plastic. The measurements demonstrate that plastic track detectors can be conveniently and easily utilized in accurately monitoring the astronauts high LET radiation exposure on extended space missions lasting up to several years. (auth) (France)

44640 NEUTRON MEASUREMENTS WITH FISSION FOIL DETECTORS. Gruenauer, F.; Burger, G. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). pp V.58-70 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Mathematical procedures for evaluating both integral and differential neutron flux densities with fission foil–dielectric track detectors are discussed. (W.H.K.)

44641 APPROXIMATE DOSIMETRY AND SPECTROMETRY OF FISSION AND THERMONUCLEAR NEUTRONS WITH VISUAL PLASTIC DETECTORS. Remy, G.; Ralarosy, J.; Tripier, J.; Debeauvais, M.; Stein, R. (Univ., Strasbourg). pp V.72-83 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The characteristics and operating principles of a personal neutron dosimeter using Makrofol and nitrocellulose as visual detectors, are given. The products produced by the (n,f) and (n,α) reactions are recorded. The energy spectrum analyzed extends from thermal energies to about 20 MeV. The (n,p) (recoil protons) reactions are currently being studied in order to increase the accuracy of neutron measurements in the energy range extending from resonance to one hundred keV. (France)

44642 DIELECTRIC PLASTICS AS HIGH EXPOSURE GAMMA-RAY DETECTORS. Frank, A. L.; Benton, E. V. (Naval Radiological Defense Lab., San Francisco). pp V.84-92 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Dielectric plastics are being developed as high exposure dosimeters. The principle of operation is based on the relation between the absorbed dose and the increased chemical reactivity of these dielectric solids. Polycarbonate plastics can be utilized in measuring absorbed dose in the range of about 10^7 to 10^9 rads. The advantages of the technique lie in the low cost of the detectors, ease of data readout, and high degree of reproducibility achievable. It is hoped that the method can be extended to include the dosimetry of massive doses of soft, low penetrating power x or gamma radiations. (auth) (France)

44643 HIGH ENERGY NEUTRON FLUX DETECTION WITH DIELECTRIC PLASTICS. Frank, A. L.; Benton, E. V. (Naval Radiological Defense Lab., San Francisco). pp V.93-102 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

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Dielectric plastics were irradiated with high energy neutrons to investigate their usefulness as flux detectors. Shields thick to heavy particles and of varying composition were placed in front of the plastics to test their effectiveness as radiators. Track producing particles resulted from (n,^{4}He) reactions and from recoils of light nuclei. Elements possessing high (n,^{4}He) cross sections were chosen as shields along with other heavy elements chosen to screen the surface of the plastic from all

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external track-producing particles. Carbon and aluminum satisfied the second. After etching, the track densities in cellulose nitrate were counted. The sensitivity under graphite varied from about 2.7×10^{-5} to 3.4×10^{-5} tracks/cm^2-n_0/cm^2 for neutrons between 13.1 and 17.1 MeV. Useful track densities are produced by fluxes in the range of about 2×10^8 to 5×10^{10} n_0/cm^2. The $^{12}C(n,n'3\,^4He)$ reaction also took place in the carbon nuclei within the plastic itself. This allowed the triple-^{4}He particle tracks to be counted. The sensitivity of this method varied from about 2.7×10^{-8} to 5.7×10^{-8} tracks/cm^2-n_0/cm^2. The useful flux range in the best case (under gold) was from 5×10^{10} to 5×10^{11} n_0/cm^2. (auth) (France)

44644 NEUTRON FLUX MEASUREMENT USING FISSIONABLE ELEMENTS AND SOLID TRACK DETECTORS. Talagrand; Serbat (Laboratoire Central de l'Armement, Arcueil, France). pp V.103-13 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The number of fission tracks registered under neutron irradiation with a solid track detector associated with a thick fissionable coating is calculated. The experimental results are given. The possibility of using these detectors in physical dosimetry and in radiology is discussed. Their specific qualities are underlined. (France)

44645 APPROXIMATE NEUTRON SPECTROMETRY IN AIR WITH SOLID TRACK DETECTORS. Talagrand; Serbat (Laboratoire Central de l'Armement, Arcueil, France). pp V.114-31 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A neutron spectrometry system made of solid track detectors and fissionable elements is described. This system is used for determining the neutron spectrum in air from a fission source. The formation of an equilibrium spectrum is verified. (France)

44646 ALPHA PARTICLES OF NATURAL RADIOACTIVITY IN AIR MEASURED BY CELLULOSE NITRATE PLASTIC DETECTORS. Meyerbroeker, H. (Univ., Kiel). pp VI.5-11 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A defined volume of air (related to 760 torr) has been filtered in a commercial dust collector. In front of the filter, pieces of emulsion (50 μ thick) and cellulose nitrate (50 μ thick) were placed at a distance of 1.3 cm from the filter surface. The daughter products of ^{222}Rn and ^{220}Tn have been collected on the filter. The alpha decay of the contamination was registrated in emulsion and cellulose nitrate. A method first given by Somogyi, Debrecen, was used to get the energy spectrum of the alpha particles. It is possible to determine energies of normal incident alpha particles by measuring the diameters of their tracks as a function of the etching time. A peak of 7.7 MeV which is produced by alpha particles of ^{214}Po was measured. The contents of ^{222}Rn and ^{220}Th in air can be calculated using the counted number of all registrated tracks. These measurements agreed with measurements performed in emulsion on the same subject. An electronic counter was used to check the measurements of the contents of ^{222}Rn and ^{220}Tn. (auth) (France)

44647 CALIBRATED U–Th GLASSES FOR NEUTRON DOSIMETRY AND DETERMINATION OF URANIUM AND THORIUM CONCENTRATIONS BY THE FISSION TRACK METHOD. Schreurs, J. W. H. (Corning Glass Works, N. Y.); Friedman, A. M.; Rokop, D. J.; Hair, M. W.; Walker, R. M. pp VI.34-40 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A series of standard uranium glasses was prepared. A primary standard containing 41 ppM of added U had its concentration and isotope ratio verified by mass spectrometry and by fission track techniques. Secondary standards were compared to the primary standard using the fission track technique. These glasses are useful for measuring both Th and U in solids. The U concentration in an unknown is determined by comparing the fission track density induced by thermal neutron irradiation with the corresponding density in the standard. Th is measured by a cyclotron irradiation using the same U standards. The glasses are also useful for neutron dosimetry. Investigators may obtain small samples of most of these standards from R. H. Brill of the Corning Museum of Glass. Although most of the glasses were fabricated from depleted uranium, one standard containing natural uranium is available. A standard Th glass with concentration of 41 ppM was also made. (auth) (France)

44648 NUCLEAR PHYSICS AND SPECTROMETRY. Debeauvais, M. (CNRS., Strasbourgh). pp VIII.2-8 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A short review is made of the different track detectors used in nuclear physics and spectrometry, and their principal characteristics are given. (France)

44649 APPLICATION OF SOLID-STATE TRACK DETECTORS FOR MEASURING ALPHA-PARTICLE ANGULAR DISTRIBUTIONS IN NUCLEAR REACTIONS. Somogyi, G.; Schlenk, B. (Magyar Tudomanyos Akademia Atommag Kutato Intezete, Debrecen, Hungary). pp VIII.27-40 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The track diameter of particles entering the track detectors at right angles shows a strong dependence on the energy and the type of particles. Some general features of this effect are discussed. It is shown that, even in glass, different heavy nuclei can be distinguished according to their track diameters. New data are presented for alpha particles registrated in Macrofol E. Using the correlation between alpha particle energy and track diameter, detailed investigations have been carried out to measure angular distributions of alpha groups from nuclear reactions. Preliminary experimental results obtained for the reactions $^{19}F(d,\alpha)$ and $^{27}Al(d,\alpha)$ at very low bombarding energies are presented. (auth) (France)

44650 STUDY OF HAMMER TRACKS REGISTERED IN CELLULOSE NITRATE. THESE TRACKS CORRESPOND TO ^{8}B, ^{8}Li AND ^{8}He FRAGMENTS COMING FROM A GOLD TARGET BOMBARDED BY A 19 GeV/c PROTON BEAM. THE FRAGMENTS WERE ANALYZED WITH A 12 KGAUSS MAGNETIC FIELD. Aiguabella, R.; Prohl, R.; Schmitt, R. (CNRS, Strasbourg). pp VIII.47-52 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

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Fragments emitted in 19 GeV/c proton interactions with complex nuclei (Be, C, Al, Ag, and Au) were studied. The fragments coming from homogeneous targets were analyzed in a vacuum cell by a 12 kG magnetic field and collected in plastics and emulsion visual detectors. Hammer tracks registered in cellulose nitrate and corresponding to ^{8}B, ^{8}Li and ^{8}He fragments coming from a gold target bombarded with a proton flux of 10^{14} protons/cm^2 were particularly studied, in order to find ^{8}He. (France)

44651 COMMENTS OF A PAPER ON ELASTICALLY SCATTERED RECOIL NUCLEI IN SOLID-STATE DETECTORS. Maurette, M.; Walker, R. M. (Washington Univ., St. Louis). pp VIII.53-64 of Proceedings of the International Topical conference on Nuclear Track Registration in Insulating Solids and Applications,

Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Horn and Von Oertzen have suggested using elastically scattered recoil nuclei to measure the registration characteristics of solid state track detectors. To support this suggestion they have shown pictures of tracks, in mica, that they have attributed to elastically scattered K and Fe nuclei produced by irradiation with 32 MeV ^{16}O ions. Although this is an interesting observation, it is believed that their interpretation is incorrect. It is first shown that the measured characteristics of the tracks do not match the theoretically predicted features for elastic processes. Furthermore the experimental features are consistent with those predicted for inelastic (mostly compound nucleus) reactions. However, the possibility cannot be ruled out that they are produced by contaminant ions present in the incident beam. (auth) (France)

44652 VARIOUS APPLICATIONS OF DIELECTRIC TRACK DETECTORS. Monnin, M. (Univ., Clermont-Ferrand, France). pp IX.2-5 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A brief review is given of dielectric track detector applications in biology, metallurgy, and reactor physics. They can also be used for studying liquid or gas motion, for polymer electrolytic metallization and catalytic wall fabrication. (France)

44653 OBSERVATION OF FLUORESCENT TRACKS. Parizet, M. J.; Monnin, M. (Univ., Clermont-Ferrand, France). pp IX.6 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A method using fluorescence was developed in order to reduce background noise and measure nuclear tracks to a greater accuracy. The method utilizes the fact that the tracks are hollow canals. (France)

44654 APPLICATION OF SOLID STATE TRACK RECORDERS FOR NEUTRON SPECTRA MEASUREMENTS IN A REACTOR IRRADIATION FACILITY. Koehler, Wilfried (International Atomic Energy Agency, Vienna). pp IX.7-11 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

In connection with the IAEA-neutron seed irradiation program, a standard neutron irradiation facility was constructed. The application of solid state track recorders for fast neutron spectra measurements inside this facility is discussed. Fissionable targets of ^{235}U, ^{239}Pu, ^{237}Np, ^{238}U and ^{232}Th will be used, and an approximative solution for the incident neutron spectrum will be obtained by a five group method. (auth) (France)

44655 USE OF SOLID STATE NUCLEAR TRACK DETECTORS IN REACTOR PHYSICS EXPERIMENTS. Tuyn, J. W. N. (Reactor Centrum Nederland, The Hague). pp IX.12-33 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Solid state nuclear track detectors of silver-activated phosphate glass and polycarbonate plastic have provided intracell fission density and fast neutron flux distributions in the zero-power critical facility NORA (Institutt for Atomenergi, Kjeller, Norway). The fission density distributions were measured in a clean lattice and within fuel elements in the vicinity of grey absorber control elements. The measured intracell fast neutron flux distributions were used for the evaluation of the so-called fast advantage factors (fuel-to-moderator neutron flux ratios at fission energies). Integral measurements of the fast advantage factors were performed by foil activation. As far as the experimental results presented here could be compared with theoretical calculations a good agreement was found. For the measurement of the track density distributions along the detector surface a method was developed which replaces the counting procedure of tracks under a microscope. This method is based upon the relation between track density and intensity of transmitted light through irradiated and etched detectors, whereby a microdensitometer is used for the measurement of the light transmission. Some remarks about the fast neutron sensitivity of Makrofol polycarbonate plastic are made. (auth) (France)

44656 ENVIRONMENTAL NEUTRON MEASUREMENTS WITH SOLID STATE TRACK RECORDERS. Roberts, J. H. (Northwestern Univ., Evanston, Ill.); Parker, R. A.; Congel, F. J.; Kastner, Jacob; Oltman, B. G. pp IX.52-5 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The suitability of using ^{10}B and ^{6}LiF in contact with cellulose acetate butyrate (CAB) for the measurement of slow neutron densities was investigated. The upper energy threshold of clear Diacel cellulose nitrate (CN) and of the CAB were also measured. The CAB in good contact with thick ^{10}B or ^{6}LiF sources offers good promise for the detection of slow neutrons. For the actual CAB samples used, the CAB–^{10}B combination had an efficiency of $\sim 1.3 \times 10^{-2}$ tracks per thermal neutron incident in a 2π solid angle. The corresponding number for the CAB–^{6}Li combination is $\sim 5.6 \times 10^{-3}$ tracks per thermal neutron. (auth) (France)

44657 RESEARCH WITH THE IRT REACTOR AT SOFIA USING FISSION FRAGMENT DIELECTRIC TRACK DETECTORS. Kachoukeev, N. T. (Bylgarska Akademiya na Naukite, Sofia). pp IX.56-60 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The results obtained in research carried out with fission fragment dielectric track detectors at the nuclear research center of Sofia in 1967 are given. The main topics covered are: the recording of neutron beams and the dosimetry of neutron fluxes; the determination of extremely small quantities of uranium in various substances; the dating of rock samples; and nuclear research. (France)

44658 DESIGN AND OPERATION OF A FAST NEUTRON POLARIMETER. Davie, H.; Galloway, R. B. (Univ. of Edinburgh). Nucl. Instrum. Methods; 92: No. 4, 547-52(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A fast-neutron polarimeter using neutron scattering from a high-pressure He gas scintillator is described. Choice of scattering angle is considered with regard to the speed of data collection and the accuracy with which the analysing power of He is known. The importance of displaying the He recoil spectra for accurate polarization analysis is emphasized. A preliminary polarization measurement on the neutrons from the $^{2}H(d,n)^{3}He$ reaction gave $(-12.9 \pm 0.7)\%$ for 390-keV deuterons and a reaction angle of 46° lab. (auth)

44659 SMALL ANGLE SCATTERING OF FAST NEUTRONS. Ali, K. Masood; Galloway, R. B.; Vass, D. G. (Univ. of Edinburgh). Nucl. Instrum. Methods; 92: No. 4, 553-7(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The reasons for interest in small-angle scattering of fast neutrons are outlined. Apparatus developed for investigating small-angle scattering of 3.5-MeV neutrons emitted in the $^{2}H(d,n)^{3}He$ reaction by using a 1-MeV accelerator is described; and its performance assessed. Preliminary measurements are presented of the differential cross sections for scattering by Cu and Pb at angles between 1.4° and 10°. (auth)

XUM

44660 ASSOCIATED PARTICLE TIME OF FLIGHT SYSTEM USING A POSITION SENSITIVE DETECTOR. McFadden, R.; Martin, P. W.; White, B. L. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods; 92: No. 4, 563-7(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The D(d,n)^{3}He reaction was used to define the equivalent of four well-collimated, contiguous neutron beams by detecting the associated ^{3}He recoil particles in a position-sensitive detector (Nuclear Triode). A PDP 8 computer, interfaced to three 256-channel analog-to-digital converters, operates on line to record the neutron time of flight, the ^{3}He energy, and the ^{3}He direction for each event. Data are stored on magnetic tape in a three dimensional format for off-line analysis by the PDP 8 or an IBM 360 computer. The system was tested by measuring the elastic scattering of 4.25-MeV neutrons from Pb at small angles (≥5°) with an instrumental time resolution of 2.2 ns fwhm. It is expected that the system will be capable of measuring scattering to a minimum angle of ≈1.5°. The technique will be used to study small-angle scattering from several heavy nuclei to compare theoretical predictions based on neutron polarizability and alpha-particle-cluster contributions to an optical-model hamiltonian that contains a Schwinger scattering term. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 44729 and 45912.

44661 (AECD/EP-19) MEASUREMENTS ON GAMMA RAY SHAPE CALIBRATION AND PEAK-TO-TOTAL RATIOS FOR A 5" x 6" NaI(Tl) SCINTILLATION DETECTOR. Ahmed, N.; Awal, M. A.; Rahman, M. A.; Khatun, S.; Rashiduzzaman, M. (Atomic Energy Centre, Dacca (Pakistan)). Jan 1971. 14p. Dep. NTIS (U. S. Sales Only).

A number of (p,γ) reactions were used to obtain the single γ-ray spectrum for shape calibration and peak-to-total ratio measurements for a 5" × 6" NaI(Tl) scintillation counter over a range of 0.662 to 8.92 MeV energy. A theoretical calculation of total absolute efficiency for such a detector was also made for source to crystal distances of 2 cm to 20 cm over an energy range of 0.129 to 100 MeV. (auth)

44662 (CEA-R-4199) ENERGY CALIBRATION AND PRECISION OF A GAMMA SPECTROMETRY UNIT: METHOD USING THE ELECTRON ANNIHILATION ENERGY AS THE ONLY STANDARD. Hoclet, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1971. 187p. (In French). Dep. NTIS (U. S. Sales Only).

Spectrometry using Ge(Li) detectors is discussed. The excellent resolution of this type of detector, the mathematical analysis of the spectral lines of the pulses, and the reproducibility of the spectrometer enable highly accurate measurements of the abscisses (some 10^{-5}) corresponding to the peaks. A method using the annihilation energy of the electron as the only standard was developed. The method is applied to the measurement of the gamma ray energies of the radioelements: ^{22}Na, ^{24}Na, ^{56}Mn, ^{56}Co, ^{59}Fe, ^{72}Ga, ^{88}Y, ^{122}Sb, ^{124}Sb and ^{137}Cs. (auth)

44663 (NYO-844-84, pp 60-9) LEAST-SQUARE ANALYSIS OF EXPERIMENTAL ALPHA SPECTRA. Trivedi, Brij M. P. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

An ALGOL program for analysis of alpha spectra is described. The program combines the spectra to correct for peak shifts due to gain and then analyzes the spectra by the least-squares method. (W.H.K.)

44664 (RD/B/N-1978) DESIGN OF GAMMA SCANNING EQUIPMENT FOR THE A.G.R. POSTIRRADIATION EXAMINATION PROGRAM. Davies, B. S. J.; Polley, M. V.; Walker, W. N. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr 1971. 36p. Dep. NTIS (U. S. Sales Only).

Appendices by J. M. Butterfield and R. M. Cornell.

A design is presented for the electronic apparatus required to control and acquire data from two gamma scanning rigs forming part of the A.G.R. post irradiation examination program. Ge(Li) gamma ray detectors, operating at high counting rates, will determine fission product activities as a function of axial position along individual fuel pins, in order to provide data for reactor physics and materials purposes. Both rigs will be controlled by a PDP 11 computer which will also log gamma ray spectra from the Ge(Li) detectors. Interfacing will be effected largely by CAMAC equipment. The nature and purpose of the measurements are discussed and a system is described which will perform these measurements with adequate rapidity. (auth) (UK)

44665 (RT/EL-(69)7) ITALIAN CONTRIBUTIONS TO THE 4th INTERNATIONAL MEETING ON ELECTRONICS AND AUTOMATION, HERCEG-NOVI, YUGOSLAVIA, 13-22 JUNE 1969. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 398p. (CONF-690657).

Separate abstracts were prepared for six of the papers in this report. Another paper, on the use of hybrid computers in the Italian CNEN nuclear program, has already appeared as NSA 23: 40440. The remaining papers, related to computer development and usage, were not in the scope of NSA. (R.W.R.)

For abstracts of individual papers see: 44666–44668, 44729, 46097, and 46334.

44666 (RT/EL-(69)7, Paper 7) LINEARITY MEASUREMENTS IN NUCLEAR SPECTROSCOPY. Cervellati, R.; Giannini, M.; Manfredi, P. F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 54p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

Much effort has been expended recently in improving the linearity features of instrumentation for nuclear spectrometry. Pertinent definitions, concepts, and methods of measurement are reviewed. These are then applied to the measurement of the nonlinearity of various analog or digital devices and circuits used in nuclear spectroscopy, such as an ADC. The block diagram for a precision pulser, such as required for the accurate calibration of electronic systems, is given. (R.W.R.)

44667 (RT/EL-(69)7, Paper 8) HIGH ACCURACY CIRCUITRY FOR PULSE PROCESSING IN NUCLEAR PHYSICS EXPERIMENTS. Manfredi, P. F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

The design and performance of fast and accurate ADC's is presented, along with associated analog processing circuitry, such as that for linear gates and peak stretchers. (R.W.R.)

44668 (RT/EL-(69)7, Paper 9) PROPOSAL FOR AUTO-EQUALIZING SYSTEMS IN ANALOG TO DIGITAL CONVERSION. Coli, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

A method for analog-to-digital conversion with good speed performance and intrinsic statistical equalization of the channel width (Autoequalization) is described. The basic idea is to get a digital "prevision" of the final value of the amplitude to be measured before analyzing the pulse with conventional methods. In this way the measurement is performed only on the difference between the input and the analog conversion of the digital "prevision". Two methods for doing this are considered: one takes information from previously analyzed pulses; the other, from the same incoming pulse. The equalization method is also used with time-to-pulse height converters. Two possible realizations are treated: the first allows improvement of the differential linearity, the second allows a reduction of the time of analysis associated with the multichannel pulse-height analyzer. (R.W.R.)

44669 (SAN-549-7) RESEARCH AND DEVELOPMENT ON SINGLE CRYSTAL HIGH RESISTIVITY CADMIUM TELLURIDE FOR USE AS A GAMMA-RAY SPECTROMETER. Annual Summary Report, January 1–December 31, 1970. Zanio, Kenneth R. (Hughes Research Labs., Malibu, Calif.). Contract AT(04-3)-549. 89p. Dep. NTIS.

Single crystals of semi-insulating cadmium telluride (CdTe) have been grown from the vapor and by a modified Bridgman technique for room temperature gamma spectroscopy. Surface barrier detectors fabricated from this material were found to resolve photopeaks from monochromatic x-ray and gamma emitters ranging in energy from 59.6 keV (^{241}Am) to 1.33 MeV (^{60}Co). At room temperature a peak-to-valley ratio of 9 to 1 was found with ^{57}Co (122 keV), using a device having an active volume of approximately 15 mm^3. For another device of similar dimensions, 9 keV resolution was measured using 59.6 keV x-rays. The improvement in resolution is due to the growth of more homogeneous vapor-grown and Bridgman-grown single crystals. Resolution is limited by incomplete charge collection which in turn is restricted by precipitates and trapping at point imperfections. Transient response measurements show the electron trapping

time to increase an order of magnitude with increasing electric fields and indicate the drift velocity at low temperature and at low electric fields to be correlated with the trapping time and presumably with scattering by ionized defects. (auth)

44670 IMPROVEMENTS IN AND RELATING TO NEUTRON SPECTROMETERS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,238,213. 7 Jul 1971. Priority date 15 Sep 1967, Netherlands.

A neutron spectrometer composed of a hydrogen-rich foil such as polyethylene and a semiconductor telescope detector is described. (W.H.K.)

44671 INTEGRAL TECHNIQUES FOR THE MEASUREMENTS OF INTERMEDIATE NEUTRON SPECTRA. Sekiguchi, Akira; Nishino, Osamu (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A; No. 8, 44-5(Dec 1970). (In Japanese).

The application of the spectral index method for the measurements of neutron spectra and dose in the intermediate energy region has been studied. The method has been applied for the high sensitivity measurements of rem dose using a ^{6}Li glass scintillator, and for the determination of effective cut-off energy of ^{10}B covered detectors. The 1/E neutron field in the graphite standard pile has also been determined by the same method, and the energy dependent perturbation effect in the moderator has been studied experimentally by using the lead slowing down time spectrometer. (auth) (Japan)

44672 COMPUTATIONS RELATING TO γ-RAY SPECTROSCOPY. Bibby, D. M.; Oldham, G. (Loughborough Univ. of Tech., Eng.). J. Inst. Nucl. Eng.; 12: No. 3, 63-6(May–Jun 1971).

Standard computations used in γ ray spectroscopy are reviewed. Various methods of spectrum smoothing, with their advantages and limitations are considered. Techniques for locating peaks by computer program are noted. These include the fit of a modified Gaussian to the whole photopeak and searching for the change in sign of the first derivative of the smoothing function. Use of semiconductor detectors in this context is discussed. Gain shift corrections including treatment of the spectrum as a histogram are outlined. Variations on the classical techniques for determining peak area are described, and determination of this area using Covell's method and the fit of a modified Gaussian function are discussed with their disadvantages and attractions. The technique of spectrum splitting, though having some advantages, has now been largely replaced by the least squares method of analysis. The latter is discussed and a list of computer programs for various aspects of this method is given. (38 references) (UK)

44673 SPECTROMETER FOR STUDY OF (n,α) REACTIONS AT 14 MeV. Loude, J. F.; Perroud, J. P.; Sellem, Ch. (Univ., Lausanne, Switzerland). Helv. Phys. Acta; 44: No. 1, 33-48 (15 Feb 1971). (In French).

A spectrometer was constructed for the study of (n,α) reactions at 14 MeV. By detecting the ^{4}He particle associated with neutron production, it is possible to measure the α time-of-flight in addition to the residual energy and energy loss, as measured by a telescope comprising a semiconductor detector and two proportional counters. The differential cross section for the reaction ^{12}C(n,α_0)^{9}Be was measured for several angles. (auth)

44674 MONTE CARLO CALCULATIONS FOR THE PHOTOFRACTIONS AND ENERGY LOSS SPECTRA OF Ge(Li) SEMICONDUCTOR DETECTORS. Gaggero, G. (CETIS, Ispra, Italy). Nucl. Instrum. Methods; 94: No. 3, 481-92(1971).

Monte Carlo calculations for the photofractions and energy loss spectra of Ge(Li) semiconductor detectors are described. Leakage of secondary gamma rays, bremsstrahlung, and electrons is considered. Calculated photofractions, absolute peak efficiencies, and energy loss spectra are presented for crystals of different geometry and size. Monoenergetic broad and narrow parallel beam sources were used; the source energy ranged from 0.323 to 1.78 MeV. The present work is a collection of results of calculations performed in connection with several particular problems. (auth)

44675 EVALUATION OF EPITAXIAL n-GaAs FOR NUCLEAR RADIATION DETECTION. Eberhardt, J. E.; Ryan, R. D.; Tavendale, A. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Instrum. Methods; 94: No. 3, 463-76(1971).

The high purity of n-GaAs grown by the liquid phase epitaxial process makes it suitable for the evaluation of this compound semiconductor in nuclear radiation detection. The wide band gap and high atomic number make it possible to operate surface-barrier diodes at room temperature as high-resolution detectors. The resolutions (fwhm) at 300 K are found to be 21 keV for 5.49-MeV α particles and 2.5 keV for 140 keV γ rays. The best resolutions observed were 640 eV (130 K) for 59.54-keV γ rays, 1.3 keV (200 K) for 84-keV conversion electrons, and 16 keV (205 K) for 8.785-MeV α particles. The thickness of the epitaxial region was $\approx$60 μm with contact diameter up to 3 mm. The energy per electron–hole pair for α particles is 4.27 eV $\pm$ 0.05 at 300 K with a linear variation with band gap of 2.7 over the temperature range 87 K to 340 K. The Fano factor for γ rays is $\leq 0.18 \pm 0.04$ (T $\approx$ 125 K). Variations of capacitance and pulse height with detector bias, as well as etch patterns, indicated a discontinuity in the impurity density profile in the region of the interface between the substrate and the epitaxial layer. Consideration of the theory of excess carrier recombination in direct band gap semiconductors shows that the charge collection efficiency is not expected to be significantly reduced by direct radiative recombination, even in the case of fission fragments. This is confirmed by the experimental observations that ^{252}Cf fission-fragment energy deficits of 14.4 and 6.3 MeV are not much larger than have been observed with Si detectors. The advantages of room-temperature operation open up a wide field of application for GaAs detectors in both the physical and biomedical fields. For their full exploitation it will be necessary to grow thicker layers of high-purity GaAs by the epitaxial or some other process, to overcome the problem of signal attenuation at the epitaxial–substrate interface, and to develop a more rugged form of front contact and of detector encapsulation. (auth)

44676 TWO-CRYSTAL GAMMA SPECTROMETER WITH RAPID–SLOW COINCIDENCE FOR ANALYZING MIXTURES OF RADIOACTIVE ISOTOPES. Kireev, V. A.; Navalikhin, L. V.; Sattarov, M. G.; Talanin, Yu. N. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 73-6(1970). (In Russian).

The use of a coincidence circuit jointly with amplitude measuring equipment greatly widens its field of application, permitting a study of nuclear decay schemes. The proposed spectrometer with rapid-fast coincidence consisted of two scintillation detectors, two channels for amplitude analysis, and an amplifier and discriminator. The "rapid" double coincidence circuit had a resolution time of 2×10^{-8} sec, and the "slow" triple coincidence circuit–0.6×10^{-6} sec. Examples of use of the apparatus in investigating a mixture of radioisotopes are given. (K.S.W.)

44677 POSITION SENSITIVE COUNTER TELESCOPE FOR THE STUDY OF NUCLEAR REACTIONS INDUCED BY 14 MeV NEUTRONS. Valkovic, V.; Tomas, P. (Inst. Ruder Boskovic, Zagreb). Nucl. Instrum. Methods; 92: No. 4, 559-62(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A counter telescope consisting of two multiwire proportional chambers and a residual-energy charged-particle detector is described. Instead of using a standard proportional counter, two batteries of gas proportional counters were incorporated into the tandem arrangement of the detectors. The position-sensitive part was made from stainless steel wires, 0.02 mm in diameter, with a wire spacing of 5 mm. The distance between the mesh and the wires was 15 mm. The lumped delay-line method was used to determine the identification pulse that is position sensitive. The spectra of the energy loss in the chamber were measured in the proportional region. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 45312 and 45626.

44678 (CERN-Trans-71-11) SPECTROMETRIC CHARACTERISTICS OF THE TOTAL ABSORPTION CHERENKOV COUNTER WITHIN THE NANOSECOND TIME REGION. Bekrenev, V. S.; Kruglov, S. P.; Shchetkovskii, A. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated by R. Luther (CERN, Geneva, Switzerland), from Report 197. 22p. Dep. NTIS (U. S. Sales Only).

The background in total absorption spectrometric counters is estimated for given values of the pulse pile-up probability. Methods of constructing electronic recording systems are examined and the main circuits of the basic logical elements are shown. An experimental investigation is made of the spectrometric and time characteristics of the total absorption Cherenkov counter. The value of the counter's energy resolution, determined as the relation of the total width half-height of the pulse distribution curve pulse-height to the maximum varies from 42% to 16% within the msec time region and from 53% to 22% within the nsec time region when the incident electron energy rises from 100 MeV to 600 MeV accordingly. The instrument's efficiency $\approx$ 100%. (auth)

44679 (IFVE-SEF-70-48) HIGH RESOLUTION DIFFERENTIAL CHERENKOV COUNTERS. Gorin, Yu. P.; Denisov, S. P.;

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Donskov, S. V.; Krasnokutskii, R. N.; Petrukhin, A. I.; Prokoshkin, Yu. D.; Stoyanova, D. A.; Shuvalov, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Differential Cherenkov counters that detect Cherenkov light at the angles of 23 and 12 mrad are described. The counter lengths are 5 m (Θ = 23 mrad) and 10 m(Θ = 12 mrad). The spectrum band of the counters is 2500 to 6000 A. The counter characteristics have been investigated in 35 to 45 GeV/c beams of the 70 GeV accelerator. The velocity resolutions measured are equal to 2.10^{-6} for a 10 m counter and 6.10^{-6} for a 5 m counter. The 10 m counter can separate pions and kaons up to 200 GeV/c and kaons and protons (antiprotons) up to 350 GeV/c. (auth)

44680 (IFVE-SPK-70-59) SHAPING DEVICES FOR GRATING AND TRACK SIGNALS. Ivchenko, V. E.; Ivanov, A. A.; Khromova, G. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

Devices used in systems for measuring tracks on chamber pictures are described. These devices shape signals from photomultipliers of film and grating channels. Principal schemes of units of such the devices are given. Some improvements for increasing the resolution and accuracy to separate signals from the photomultipliers are realized. (auth)

44681 (IFVE-SPK/OPI-70-56) DIGITIZER FOR CODING THE CENTER OF THE HPD TRACK SIGNAL. Gerasimov, B. Ya.; Ivanov, A. A.; Ivchenko, V. E.; Khromova, G. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

A digitizer for coding the center of the track signal with respect to the grating impulses provided with a geometric link system (on the basis of grate) in the HPD channel is described. The method used is briefly described and two modifications of the device construction are considered: on tunnel diodes and on high frequency transistors (for work at the HPD disc rotation speed up to 6000 rotations per minute) and on integral schemes (for work at 3000 rotations/minute). Principal schemes and main experimental characteristics of the device are given. (auth)

44682 (IFVE-SPK/SVM-70-53) COVARIANT MATRIX OF MEASURING COORDINATES OF TRACK POINTS TAKING INTO ACCOUNT COULOMB MULTISCATTERING. Gerdyukov, L. N.; Zhigunov, V. P.; Zhigunova, I. A.; Klimenko, S. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Proceeding from the assumption that the distribution density of the coordinates of the track points on the pictures from the bubble chambers is defined by two independent factors, i.e. stochastic movement of the particles in the medium and accidental measuring processes, and using the theorem of marginal distribution of multidimensional normal distribution, a covariant matrix for measuring the coordinates of the track points has been obtained. The Coulomb multiscattering is taken into account. (auth)

44683 (JINR-P13-5811) INFLUENCE OF THE MAGNETIC FIELD ON THE SPARK CHAMBER EFFICIENCY. Nekrasov, K. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

More precise value of the criterion for the formation of the spark clamp in neon is obtained on the basis of the shower-streamer theory of discharge. It is shown that the maximum resolution time of spark chambers depends on the zone dimensions necessary for the discharge development. The influence of the magnetic field on the parameters determining the spark chamber efficiency is considered. (auth)

44684 (JINR-P13-5866) ACHROMATIC METHOD FOR MEASURING THE MEAN ENERGY OF PROTONS IN A 654 MeV BEAM BY MEANS OF VAVILOV-CHERENKOV RADIATION. Zrelov, V. P.; Pavlovich, P.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The achromatic method for measuring the mean energy of protons by using Vavilov-Cherenkov radiation and the results of its test on a proton beam at ~660 MeV are described. The measurement accuracy of ±0.20 MeV is achieved by this method. (auth)

44685 (NP-18930) PRESSURE VARIATION SYSTEM OF A 4.5 METER BUBBLE CHAMBER. Astakhov, A. V.; Bol'shakov, V. A.; Grad, G. A.; Popkovich, A. V.; Kuznetsov, E. P.; Samarin, M. A.; Snyatkov, V. I. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction and operation principle of the pneumatic pressure variation system of the 4.5-m bubble chamber are presented. This system allows to decrease the pressure of the chamber expansion volume from 30 up to 8 atm within ~60 msec and to increase it from 8 up to 30 atm within ~40 msec. The system for restoring the reference pressures in receivers after each expansion cycle is considered. (auth)

44686 (SJC-T-71-2) PNEUMATIC EXPANSION SYSTEM OF THE 75 CM HYDROGEN BUBBLE CHAMBER. Tateno, H.; Hamatsu, R.; Hirabayashi, H.; Ikeda, H.; Ishihara, N.; Kato, S.; Kita, I.; Taino, M.; Yoshimura, Y. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Mar 1971. 17p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A pneumatic expansion system for the 75 cm hydrogen bubble chamber which can give the liquid hydrogen the expansion of about 1% of the liquid volume was constructed and used successfully for the test operations of the bubble chamber to take the pictures of cosmic ray tracks. Components of the system and the operating characteristics are reported. The piston stroke and the time width of the stroke can be controlled widely by adjusting the parameters involved in the system. (auth) (Japan)

44687 SENSITIVITY OF WEBER'S ANTENNA FOR SHORT PULSES OF GRAVITATIONAL RADIATION. Rudenko, V. N. (Moscow State Univ.). Phys. Lett.; 35A: No. 6, 409-10(12 Jul 1971).

The sensitivity of a gravitational mass-quadrupole detector is calculated if it registers according to the rate of change in the output signal. A limit is given for the connection coefficient of a piezo-transducer with detector. (auth)

44688 PARTICLE TRACK STORAGE IN STREAMER CHAMBERS. Eckardt, V. (Deutsche Elektronen-Synchrotron, Hamburg). Lett. Nuovo Cim.; 1: No. 24, 997-1000(12 Jun 1971).

A method was developed for storing particle tracks in streamer or other spark chambers. The storage time may be up to a few msec, i.e., a factor of a thousand longer than the electron lifetime that determines the time resolution of the chamber. Two high-voltage pulses are used: the first permits storage of track information, while the second allows photographic recording of a second avalanche caused by electrons resulting from collisions of metastable atoms formed in the first avalanche. The loss of spatial resolution by diffusion is negligible, especially when the chamber is operated in a magnetic field. The method is of importance in those applications where the selection of events is so involved that a computer is necessary. (R.W.R.)

44689 DEVELOPMENT OF EQUATIONS FOR THE ORIENTATION ERROR INHERENT IN A LINE-ELEMENT SCANNER. Mifsud, Lewis. New Brunswick, N. J.; Rutgers-The State Univ. (1970). 158p. University Microfilms Order No. 71-12,261. Thesis.

A theoretical analysis of the major effects producing undesirable electron beam and image rotation in a flat-face cathode ray tube is described. The orientation errors resulting from an unbalanced irrotational and dynamic focusing system and a nonlinear deflection-projection system are taken into consideration. This analysis is applied to the design of the PEPR computer-controlled measuring device for measuring bubble chamber tracks. (TSS) (Diss. Abstr. Int., B)

44690 HIGH RESOLUTION BEAM HODOSCOPE USING MULTIWIRE PROPORTIONAL CHAMBERS. Merkel, B. (Faculte des Sciences, Orsay, France). Nucl. Instrum. Methods; 94: No. 3, 573-8(1971).

A multiwire proportional chamber, using 9-μm tungsten wires, with 1 mm spacing and 2.3 mm gap was built for use as a precise beam hodoscope. An electronegative vapor (freon 13 B 1) is used to restrict the sensitive region to a small volume around the wire. In order to obtain a high detection efficiency for relativistic particles, i.e. a high probability of producing one ion pair in the sensitive volume around the wire, xenon is used as filling gas, with propylene as co-xenon (quencher). An arrangement of four identical chambers, staggered so as to give an effective wire spacing of 0.25 mm, gives a high detection efficiency (98.8 ± 0.15% for 400-MeV electrons) together with good spatial resolution. Measurements using a collimated electron beam gave a trajectory determination with 0.15 mm accuracy (half width at half maximum). (auth)

44691 VERSATILE HIGH PRECISION WIRE CHAMBER WINDING MACHINE. Bird, L.; Peter, A.; Raffler, L.; Walters,

J. (Carleton Univ., Ottawa). Nucl. Instrum. Methods; 94: No. 3, 585-6(1971).

The design of a simple wire-winding device for spark and proportional chambers is described. The advantages of this design over others are discussed. (auth)

44692 THRESHOLD GAS CHERENKOV COUNTER FOR A 200 GeV/c BEAM. Yovanovitch, D. D. (Argonne National Lab., Ill.); Rust, D. R.; Ambats, I.; (and others). Nucl. Instrum. Methods; 94: No. 3, 477-80(1971).

A test of a prototype gas Cherenkov counter is described. The emphasis was on testing various photomultipliers with extended quantum efficiency in the ultraviolet. (auth)

44693 CALIBRATION OF PLASTIC TRACK DETECTORS FOR USE IN COSMIC RAY EXPERIMENTS. Blanford, G. E. Jr.; Walker, R. M.; Wefel, J. P. (Washington Univ., St. Louis). pp IV.60-72 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 1. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.1).

The response of plastic track detectors to heavy charged particles from the HILAC at Berkeley, California, was determined. The rates of track etching as a function of particle charge and velocity are presented for cellulose tri-acetate and cellulose acetate butyrate plastic and are compared to previously measured response curves of Lexan polycarbonate and cellulose nitrate plastics. Application of these data to the determination of nuclear charges by the method proposed by Price et al is discussed. A variant of this method based on measurements of track diameters is also presented. Finally, data on the change in calibration for plastics exposed to different environmental conditions prior to etching are presented. No effect of gamma irradiation is observed up to a total dose of 18,000 roentgen. In contrast, there is a marked effect on the rate of track etching between samples stored in air at different temperatures after irradiation. (auth) (France)

Radiation Dosimeters

Refer also to abstracts 44735, 44806–44809, 44813, and 44888.

44694 (UCRL-73254) ORGANIZATION ASPECTS OF A PERSONNEL DOSIMETRY SERVICE. Rich, B. L.; Samardzich, B. G. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Jun 1971. 33p. (CONF-710710-3). Dep. NTIS.

From sixteenth annual Health Physics Society meeting; New York, N. Y. (12 Jul 1971).

Some practical application aspects of personnel dosimetry are discussed. Points made are: (1) The ultimate dosimeter does not exist. TLD appears to be the current best choice for most applications. (2) It is improbable that any one dosimeter will serve all needs equally well. Several dosimeter systems throughout the industry seem unavoidable. (3) An intercalibration organization should be established to foster improved accuracy in calibration and processing. Participation should be voluntary. (4) Commercial services are valuable to smaller contractors but larger services benefit economically and from a convenience standpoint by providing the service "in house." (5) Certain low risk groups should be placed on an annual or semi-annual frequency for convenience, sensitivity and economy. Certain difficulties in background determination, fading, etc., should be evaluated for each application. (6) Results from any current personnel dosimeter should be treated as a piece of data rather than the final answer, particularly in significant exposures. Professional investigation and evaluations must be made. (7) Automation reaches an equilibrium point. At some point further automation is not justified from an economy standpoint. (8) Personnel dosimeter change by in-plant mail is recommended. (9) Much improvement is necessary in record keeping to provide ready access to details required in statistical studies and various types of required reports. Treatment of internal dosimetry data should also be improved and standardized where feasible. (auth)

44695 EFFECTS OF THE RELATIVE HUMIDITY ON TRACK FADING AND PREVENTION OF FADING OF THE PERSONAL NEUTRON MONITORING FILM. Nishi, Tatsuo (Japan Atomic Energy Research Inst., Oarai); Izumi, Yukio; Hirawawa, Yuki. Hoken Butsuri; 5: No. 4, 179-85(Dec 1970). (In Japanese).

In JAERI, Kodak Personal Neutron Monitoring Film, Type A–NTA film–has been used to estimate personal exposure dose due to fast neutrons. Track fading, the spectrum of tracks after fading, and prevention of track fading of the NTA film were investigated at various relative humidities of the atmosphere. The phenomenon of track fading of the NTA film was remarkable at higher relative humidity and the fading curves consist of two components of exponential function. Dose dependence of fading was not observed. As relative humidity and storage time increased, track length became shorter and the grain density of the track decreased. Track fading is prevented by wrapping the NTA film with vinylidene chloride film and putting in the badge case. (auth) (Japan)

44696 METHOD FOR MEASURING PULSED X-RAY WITH LOW INTENSITY. Takeda, Michihiko (Government Industrial Research Inst., Nagoya, Japan); Kaminishi, Tokishi; Ituta, Shiro; Yasuda, Kyoichiro; Kanaji, Toru. Hoken Butsuri; 6: No. 1, 3-8 (Mar 1971). (In Japanese).

The response of a scintillation counter type survey meter was examined by using pulsed X-rays from an electron linear accelerator, and it was confirmed that the survey meter indicates incorrect values due to the "pile-up effect." In order to eliminate this weak point, a scintillation dose rate meter which gives the value proportional to the dose rate of pulsed X-rays was developed. The average value of the photoelectronic current proportional to the quantity of light generated in the scintillator by X-ray burst can be measured with this dose rate meter. To obtain a higher sensitivity dose rate meter, a 2″ × 2″ NaI(Tl) scintillator and a dc μ-ammeter were used, and the detection limit of X-ray intensity was 0.002 mR/hr. (auth) (Japan)

44697 DATA PROCESSING OF THE RESULTS OBTAINED WITH A PHOTOGRAPHIC DOSIMETER. Bruneau, M.; Kientzel, J.; De Moras, Y. (Etablissement Central d'Electro-Radiologie des Armees, Malakoff, France). Radioprotection; 6: No. 2, 93-117(1971). (In French).

Data processing of measurements carried out with a simple two-filter photographic dosimeter is described. It gives an accurate determination of the average energy of a low energy ionizing radiation even when mixed with high energy ionizing radiations. The determination of the energy allows the exposure to be accurately calculated. Automatic processing by computer is envisaged, and applications to personal dosimetry are foreseen. (UK)

44698 NEW RADON PROGENY PERSONNEL DOSIMETER. Auxier, J. A.; Becker, K.; Robinson, E. M.; (and others) (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 1, 126-8 (Jul 1971).

A dosemeter is described for use in uranium mines, to measure radon progeny attached to aerosol particles, with little or no interference from radon gas and unattached progeny. The design includes an active motor-propeller collector system electrically charged between shifts and worn attached to the miners' helmets. The α particle detectors foil was of cellulose nitrate of 15 μ thickness. (UK)

44699 USE OF TRANS-STILBENE CRYSTAL TO MEASURE THE DOSE EQUIVALENT IN A MIXED γ–n FIELD. Bardina, R. (EURATOM–CNEN, Frascati, Italy); Ladu, M.; Pelliccioni, M.; Roccella, M. Health Phys.; 21: No. 2, 273-80(Aug 1971).

The possibility of using a trans-stilbene crystal to measure the dose equivalent in a mixed γ–n field is studied. Both γ-ray and neutron signals, separated by pulse shape discrimination, gave a good dose equivalent response to the respective radiation component. For the neutrons a good dose equivalent response was obtained in the range from 0.1 to 10 MeV (where the elastic scattering is predominant) by suitable saturation of the pulses produced by recoil protons. For the γ-rays the absorbed dose in the scintillator was measured directly due to its tissue equivalence up to several MeV. In the range of γ-rays exposure up to about 0.2 R/hr, the sum of the two measured contributions was constant, within the experimental errors, when the relative dose was varied, keeping the total dose rate fixed. (auth) (UK)

44700 CALCIUM SULFATE ACTIVATED BY THULIUM OR DYSPROSIUM FOR THERMOLUMINESCENCE DOSIMETRY. Yamashita, T.; Nada, N.; Onishi, H.; Kitamura, S. (Matsushita Electric Industrial Co. Ltd., Osaka). Health Phys.; 21: No. 2, 295-300(Aug 1971).

$CaSO_4$: Tm and $CaSO_4$: Dy were found to be free from the serious disadvantage of rapid fading in $CaSO_4$: Mn and yet retain the outstanding property of high sensitivity of $CaSO_4$: Mn, the most sensitive thermoluminescence dosimeter available at present. Glow curves of both $CaSO_4$: Dy and $CaSO_4$: Tm are rather simple showing a main peak at 220°C and shoulders at 80°C and 120°C. Emission spectrum of $CaSO_4$: Tm consists of a main sharp peak at 450 mμ with minor ones at 360, 470 and 520 mμ and $CaSO_4$: Dy has two main

XUM

peaks at 480 and 570 mμ without any minor one. The dosimetric characteristics of $CaSO_4$: Tm and $CaSO_4$: Dy are excellent except for their non-tissue equivalence: 1. little fading (1–2% per month); 2. minimal detectable exposure is lower than 200 μR with standard deviation of ±20%, by a commercial readout instrument; 3. dose response of $CaSO_4$: Dy is linear up to 3000 R and supralinear over 3000 R, and that of $CaSO_4$: Tm is linear up to 300 R and supralinear over 300 R; 4. energy dependence is large for photon energies below 200 keV but a compensation shield made of tin and lead alters the response until it is within 40% down to 30 keV; 5. tribothermoluminescence is very low (about 1/30th of that in LiF); and 6. the thermoluminescence efficiency remains constant for more than 100 readout cycles sufficient to erase the previous dose. (auth) (UK)

44701 IMPROVEMENTS ON BOTH ENERGY AND DIRECTION DEPENDENCE OF THE Mg_2SiO_4 THERMOLUMINESCENT DOSIMETER. Nakajima, T.; Kato, Y.; Kotera, N.; Eguchi, S. (National Inst. of Radiolgical Sciences, Chiba, Japan). Health Phys.; 21: No. 1, 118-19(Jul 1971).

A rod type Mg_2SiO_4(Tb) thermoluminescent dosimeter was modified with a filter of helical coil made by winding a tin ribbon into a semicylinder (minor axis: 2mm, major axis: 4mm). The energy dependence of the filtered and unfiltered dosimeter was plotted in the range 38 keV to 1.25 MeV. With the unfiltered phosphor, the response for 38 keV was about 4 times that for the energy of ^{60}Co γ-rays, the response for the filtered dosimeter at 38 keV being 1.2 times that of 1.25 MeV γ-rays. The direction dependence was also studied and standard deviations in the response of unfiltered and filtered samples between 0 and 90 deg were about 12% and 6.3%. (UK)

44702 PREPARATION AND STUDY OF $CaSO_4$–Mn SUITABLE FOR DOSIMETRY. Kasa, Imre; Roka, Otto; Kiss, Lajos. Magy. Kem. Foly.; 77: No. 3, 126-33(Mar 1971). (In Hungarian).

A study was made of the conditions of preparation of manganese-activated calcium sulfate phosphors suitable for dosimetry and their effect on the thermoluminescent properties. Under the studied experimental preparative conditions, the optimum method of introducing the activator was determined. The most favorable properties were possessed by the phosphors into which the activator had been introduced in an acidic medium before the separation of the calcium sulfate. A study of the effect of the atmosphere of heat-treatment on the sensitivity was made. It was seen that the light intensity and sensitivity of the samples prepared in air closely approached the corresponding data of the samples made in a reducing atmosphere. In every sample the γ-ray dose was measured linearly in the examined region (10^{-2} to 10^2R). Fading is 57–59% at room temperature after 8 days. The energy dependence can be decreased at 46 keV photoenergy from 10 times to 1.6 times by shadowing with an aluminium plate of 2 mm thickness. (auth)

44703 APPLICATIONS OF SEMICONDUCTOR DETECTORS WITH p–n JUNCTIONS FOR LOW-ENERGY X- AND GAMMA-RAY DOSIMETRY. Lyapidevskii, V. K.; Mandel'tsvaig, Yu. B. At. Energ. (USSR); 30: No. 5, 462-4(May 1971). (In Russian).

Semiconductor output is relatively small when used as a detector in the low energy of radiation at less than 40 keV. In order to overcome this, two semiconductor detectors were used simultaneously. The thickness of the sensitive layer for the Si detector was ~100 μ; that for the GaAs detector was ~25 μ, which gave somewhat different relative spectral characteristics for the same low-energy radiation. A graph is presented of the ratio of the signals from the two detectors, plotted against the ratio of radiation intensity to the signal of one of the detectors. Dosimetry in the region of 10 to 40 keV then becomes possible with the use of this graph in conjunction with simultaneous measurement of the two detector outputs during radiation exposure. The sources of possible error are discussed. (K.S.W.)

44704 SOLID STATE RADIATION DOSIMETRY. Proceedings of a Multidisciplinary Symposium, Seattle, Washington, November 20, 1967. Dawson, H. I.; Stoebe, T. G. (eds.). Seattle; University of Washington (1968). 106p. (CONF-671121).

Topics discussed include solid state physical theory of irradiated crystals: absorption and fluorescence from color centers, solid state luminescence dosimetry: state of the art, neutron capture gamma ray activation analysis using a lithium-drifted germanium semiconductor detector, low Z dosimetry glass development, the effect of time and temperature on the recoverable signal from LiF, non-technical factors affecting personnel dosimeter performance, factors affecting the performance of lithium fluoride dosimeters, influence of defect structures on properties of LiF crystals, a method of quantitative thermoluminescence, and the technical characteristics of and applications for phosphor–Teflon thermoluminescent dosimeters. (W.H.K.)

44705 CONTROL OF PERSONNEL NEUTRON DOSES BY FISSION FRAGMENT TRACK COUNTING IN PLASTICS. Pretre, S. B. (Institut Federal de Recherches en Matiere de Reacteurs, Wuerenlingen, Switzerland). pp V.41-57 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-6900522–(Vol.2).

A description is given of a neutron dosimeter, currently carried by personnel working at the Würrenlingen nuclear center (Switzerland). This dosimeter is as equally well adapted for measuring routine doses as it is for those likely to be encountered in an accident. It contains two detectors, each consisting of a disc of fissionable metal placed next to a plastic (Lexan) disc. The metal is composed of ^{232}Th (for the detection of fast neutrons) and an Al–^{235}U alloy (for the detection of thermal neutrons). Some of the fission fragments penetrate into the plastic disc and leave traces, which are revealed by a KOH solution and then counted using microscopic techniques. The track density is directly proportional to the neutron dose. (France)

Radiometric Instruments

Refer also to abstracts 44555 and 45421.

44706 STUDIES OF NEUTRON MOISTURE GAUGES. Suzuki, Hisao (Nippon Steel Corp., Tokyo). Tetsu To Hagane; 57: No. 1, 175-81(Jan 1971). (In Japanese).

The development, uses, and accuracy of neutron moisture gages are discussed. Causes of errors in moisture gages for feeding cokes to blast furnaces and quality control of sintered raw materials are discussed including stagnation of raw material, inhomogeneous distribution of moisture in hoppers, abrasion of the hopper wall, raw material levels in the hoppers, effects of grain size difference, effects of bulk density difference, effects of variations in raw material composition, and statistical errors. (TSS) (Japan)

44707 PRINCIPLE AND APPLICATION OF GAMMA-RAY LEVEL METERS. Sumi, Tetsuo (Hitachi Ltd., Ibaraki, Japan). Keiso; 14: No. 2, 46-50(Feb 1971). (In Japanese).

Among instruments utilizing radioactivity, γ-ray level meters have been widely used in various fields of application for many years. The main reason for its versatile application is its ability to measure the level of liquids, solids, or compound media without direct contact with the media, so that the measurement can be performed without any restriction imposed by such conditions of the media as high temperature, high pressure, or corrosive action. The principle of operation makes use of the fact that the intensity of the γ-ray decreases exponentially when it traverses the medium. The γ-ray level meters usually consist of γ-ray sources of Co-60 or Cs-137 and detectors such as GM counters or scintillation counters. Though these sources and detectors are located outside of tanks containing the media, various characteristics of measurement can be obtained according to the relative positions between them. The objects of measurement, methods of arrangement, and means for calibrations are described in relation to such applications as the metal industry, chemical and petroleum industry, paper and textile industry, glass and porcelain industry, and the mining industry. (Japan)

44708 ARRANGEMENT FOR DETERMINING THE AVERAGE HEIGHT AND THE SHAPE OF NON-PLANE SURFACES. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,238,794. 7 Jul 1971. Priority date 2 Feb 1968, Austria.

An arrangement of radiation sources and detectors for determining the average height and the three-dimensional shape of non-planar surfaces is described. The system can be used for checking the charge depth and the dispersion of the materials over the surface in a blast furnace. (W.H.K.)

44709 Id^2 COMPUTER USING A RADIOACTIVE SOURCE. Rao, D. N.; Ciftcioglu, O.; Taylor, D. (Univ. of Strathclyde, Glasgow). J. Phys., E (London); 4: No. 8, 593-4(Aug 1971).

A transducer is described to generate Id^2, (I = counting rate; d = source-detector separation), where I and d are both variables. A simplification results if the d^2 portion of the device uses nuclear techniques, in which a radioactive source is moved to correspond to a distance d or a scaled version of d from an aperture of fixed area in front of a suitable radiation detector. The unit was developed for a gamma backscatter gage to measure soil densities. (auth) (UK)

44710 ISOTOPE GAUGES: AN ANALYSIS OF SOME ERRORS IN HOT METAL THICKNESS MEASUREMENT. Macedo, F. X.; Seredynski, F. (British Steel Corp., London). Meas. Contr.; 4: No. 7, T117-24(Jul 1971).

Isotope gages are particularly suitable as thickness measuring instruments for hot metal above 5 cm. thick and their application for this purpose is continuing to increase. Some of the factors affecting the accuracy of these gauges are discussed and, a theoretical evaluation of the errors due to steel composition, temperature distribution and statistical variation is attempted. These errors are evaluated for three carbon steels. Errors in thickness measurement due to the different compositions of these steels are evaluated for the two isotope sources most commonly used for gaging purposes namely, ^{241}Am and ^{137}Cs. These isotope sources are representative of those used for the entire practical range of thickness measurement. The effect of temperature distribution across the depth of metal on the mass attenuating the γ-rays is considered and the thickness measurements so evaluated are compared with those determined assuming a homogenous stock temperature. The principle of constant absorption is described and also some of its limitations where a wide range of measurements is required. An artifice is discussed whereby some of the limitations may be overcome. (auth) (UK)

44711 RADIOACTIVE TURBIDITY GAGES. Martin, J. M. (Univ., Paris). Houille Blanche; 25: No. 8, 745-55(1970). (In French). (CONF-691135-5).

From Conference on the applications of radioelements in sedimentology; Saclay, France (18 Nov 1969).

A number of different methods and the various apparatus used in evaluating particle concentrations in water are described. A new transmission based turbidity gage is described for measuring the absorption of 60 keV gamma rays emitted by ^{241}Am and detecting turbidity above 1.3 g/l. The accuracy of this gage increases with turbidity, but its readings require correcting for water salinity. An alternative turbidity evaluation method based on measurements of the natural radioactivity of the solid particles in water is also described. This method, which gives satisfactory results, has been used in the Gironde estuary, and the results obtained have shown its measurement range to extend from one to several hundred grams/l. Results of measurements made in the Gironde estuary by sampling, optical absorption, and natural radioactivity methods are compared indicating the advantages of continuous turbidity measurement with radioactive gages, where sediment concentration exceeds 1 g/l. (auth) (France)

44712 EXPERIMENTAL GAGES FOR THE DETERMINATION OF SEDIMENT SETTLING RELATIONS AND CORE SAMPLE DENSITY. Caillot, A. (CEA, Saclay, France); Courtois, G.; Migniot, C.; Ottmann, M. Houille Blanche; 25: No. 8, 721-4(1970). (In French). (CONF-691135-4).

From Conference on the applications of radioelements in sedimentology; Saclay, France (18 Nov 1969).

The method used is based on the absorption of γ radiation. A device for measuring, with an accuracy of about 3%, the absolute density of the sediments from a drilling core contained in a plastic envelope was developed. The sample diameters were between 5 and 11 cm and their lengths between 0.5 and 3 m. The gamma source used was ^{133}Ba. A device consisting of a low energy gamma ^{155}Eu source for studying the settling variation with time of fine sediments in a test tube was developed. It operates in a vertical plane so that the settled bed can be investigated. (France)

44713 RADIOACTIVE GAGING EQUIPMENT FOR SEDIMENT MEASUREMENTS. APPLICATIONS OF NUCLEAR INSTRUMENTATION. Courtois, G. (CEA, Saclay, France). Houille Blanche; 25: No. 8, 715-20(1970). (In French). (CONF-691135-3).

From Conference on the applications of radioelements in sedimentology; Saclay, France (18 Nov 1969).

Sediment measurements based on radiation absorption are discussed and the operating principles of the following described: γ absorption and natural radioactivity turbidity gages; sediment density gages for surface and depth measurements; fine sediment consolidation and core sample density gages, and gages for sediment density measurements during pumping. The second part of the article gives a brief description of the following applications of radioactivity and radio-elements for sedimentological measurements: gammagraphy and radiography; x-fluorescence analysis; activation analysis; nuclear diagraphy and isotope generators. (auth) (France)

44714 PERMEABILITY MEASURING SYSTEM. Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,586,858. 22 Jun 1971. Filed 17 Jan 1968.

This system permits the measurement of permeability of subsurface formations in situ by injecting a neutron absorber fluid and observing the progressive change in the thermal neutron absorption cross section. (auth)

44715 CALIBRATION OF RADIOMETRIC INSTRUMENTS ON THE BASIS OF BOREHOLE MEASUREMENTS. Larionov, V. V. Tr., Mosk. Inst. Neftekhim. Gazov. Prom.; No. 89, 115-21 (1969). (In Russian).

Calibration of instruments used for borehole measurements to yield absolute values, independent of the specific instruments used, presents difficult problems. Calibration of curves obtained by the γ method against two reference media eliminates only partially the distortions resulting from the differential sensitivity of the instruments toward various ranges of the energy spectrum. It was found that good results may be obtained by choosing a reference medium, the radiation of which reflects the spectral composition of the radiation of the rocks at the well. It is therefore proposed to use a multilayer reference medium, corresponding to the cross section of the layers through which the well is drilled. The technique was demonstrated during a mining and geophysical expedition in Crimea, during which four wells were drilled through layers of marble, limestone and clay. The results revealed that the errors were greatly reduced. The water content of the rocks may be included as one of the factors in the modeling of the reference layers. (TTT)

44716 MEASUREMENT OF THIN FILM THICKNESS USING ELECTRON BACKSCATTERING. Levenes, G. (Societe Industrielle de Combustible Nucleaire, Veurey, France). pp 86-91 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

Electron backscattering was used for thin film thickness measurements, the films being deposited on foils on thick substrates. The electron backscattering increases with the thickness of the film until a saturation condition is reached, when it becomes dependent on the atomic number of the scattering material. Devices are described, which enable thicknesses between 0.01 μ and several microns to be measured in situ. These devices consist of a radioactive source and particle detectors (semiconductor for vacuum measurements and a Geiger–Mueller counter for air measurements). (auth) (France)

44717 MEASUREMENT OF VERY THIN FILM THICKNESS USING THE RUTHERFORD SCATTERING METHOD. Trapani, A.; Berlin, A. (European Atomic Energy Community, Petten, Netherlands). pp 99-105 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

The energy spectrum of a 2.5-MeV deuteron beam backscattered (175° laboratory system) from gold films deposited on vanadium, and that of a 3-MeV proton beam backscattered (175° laboratory system) from a beryllium film deposited on silver were plotted. (auth) (France)

Miscellaneous Instruments and Components

Refer also to abstracts 44314, 44501, 44665, 45609, 45846, 45875, 46097, and 46334.

44718 (BMBW-FBK-70-28, pp 225-40) RECOIL PARTICLE SPECTROMETERS. Ewald, H. (Giessen Univ. (West Germany). Zweites Physikalisches Institut).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A review of particle spectrometers for direct mass, energy, and charge analysis of nuclei recoiling as ionized products from nuclear decays and reactions is presented. These spectrometers are concerned with the low energy recoils of β-decays and K-captures as well as with the high energy recoils of fission products. (35 references). (W.H.K.)

44719 (BMBW-FBK-70-28, pp 241-54) MASS SPECTROMETER FOR THE INVESTIGATION OF FISSION PRODUCTS.

XUM

Moll, E. (Institut Max von Laue-Paul Langevin, Grenoble (France)); Ewald, H.; Wollnik, H. (Giessen Univ. (West Germany). Zweites Physikalisches Institut); Armbruster, P.; Fiebig, G.; Lawin, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A recoil mass spectrometer for the separation of unslowed fission products for studying the primary distribution of fission product mass, kinetic energy, and nuclear charge produced in thermal neutron fission is described. (W.H.K.)

44720 (BMBW-FBK-70-28, pp 255-69) GAS-FILLED MAGNETIC SEPARATORS. Armbruster, P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The design and performance characteristics of a gas-filled electromagnetic spectrometer for heavy (A > 50), fast (E/A > 0.2 MeV/nucl) recoils are described. The characteristics, calibration, resolution, and efficiency of the separator are discussed. (W.H.K.)

44721 (BMBW-FBK-70-28, pp 270-80) JUELICH ON-LINE SEPARATOR "JOSEF." Lawin, H.; Eidens, J.; Armbruster, P.; Grueter, J. W.; Huebenthal, K.; Sistemich, K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

A new gas-filled separator for separating short-lived fission products at the FRJ-2 reactor is described. The device is named JOSEF for Juelich On-line Separator for Fission-products. The in-pile installation, the magnet, the vacuum system, the detector arrangement, and expected beam properties are discussed. (W.H.K.)

44722 (CEA-R-4161) IONIC OPTICS OF MASS SPECTROSCOPES. Stefani, Rene (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Schott, Roger (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes Nucleaires). May 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only).

A comprehensive theory of ion optics was worked out by R. Herzog as far back as 1934. He demonstrated that the combined effect of an homogeneous magnetic field and a radial electric field, perpendicular to each other, on an ionic or electronic beam, was governed by the same laws as the action of a prism and a lens on light in conventional geometrical optics. An ionic beam, slightly divergent, with low energy dispersion, from the source of a mass spectrometer is focused after traversing such a field provided that the geometrical parameters of the apparatus fulfill certain conditions. The single focusing mass spectrometers, i.e., with directional focusing, include a magnetic sector, the prism and lens effects of which are purely geometric. Cartan proved that the position of the image and therefore that of the collector, can be determined by simple geometrical construction. A magnetic sector gives directional focusing for a beam of ions of identical mass and velocity, and also provides a velocity spectrum for this mass. The spread in velocity can be suppressed to the first order of approximation and the directional focusing preserved, by using given combinations of a radial electrical analyzer and a magnetic analyzer, such as to mutually compensate the velocity spread. A double focusing condition in velocity and direction is then fulfilled. Very high resolving powers can thus be attained. The geometries commonly used are those suggested either by Mattauch and Herzog or by Nier and Johnson. (auth)

44723 (IFVE-SEF-70-52) ULTIMATE TIME RESOLUTION OF THE PHOTOMULTIPLIER. Klimenko, S. V.; Shuvalov, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the paper it is shown that the best mode of the time resolution is the difference between the emission time of the first photoelectron and the mathematical expectation for the number of photoelectrons measured in this realization. (auth)

44724 (INR-1241) CHARGE-SENSITIVE PREAMPLIFIERS WITH DYNAMIC LOAD RESISTANCE (BOOTSTRAP CONFIGURATION). Wieckiewicz, J.; Lenartowicz, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 14p. (In Polish). Dep. NTIS (U. S. Sales Only).

The calculations of the dynamic load resistance and open-loop gain are described. The optimization of dynamic load resistance is discussed and examples of the practical circuits are given. (auth)

44725 (JINR-P13-5793) SCALAR OF 100 MHz FOR PHYSICAL EXPERIMENTS. Guzik, Z.; Krasovski, R.; Turala, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of High Energy). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The scalar of 100 MHz is described designed for operating the schemes of nanosecond electronics. The scheme consists of 6 decades with indication and control arranged as one unit. (auth)

44726 (NBS-10396) PRESSURE TYPE LIQUID LEVEL GAGES. Schoonover, R. M.; Houser, J. F. (National Bureau of Standards, Washington, D. C.). [nd]. 30p. Dep. NTIS.

The design and operation of a pressure-type liquid level gage are discussed. Procedures for calibrating the gage using an 800-gallon tank with water are described, and results are presented. (W.H.K.)

44727 (NP-18802) PROGRESS REPORT 14, JULY-DECEMBER 1969. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 55p. (INS-389). Dep. NTIS (U. S. Sales Only).

Brief summaries are given of work on nuclear instrumentation, accelerator development, experimental nuclear physics, radiation chemistry, radiation dosimetry, industrial applications of radiation, isotope geochemistry with stable isotopes, radioactive dating and fallout, isotope applications, and electronic equipment and instrumentation. A list of publications issued is appended. (C.E.S.)

44728 (NYO-3930-11) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH-TEMPERATURE, SODIUM ROTATING MACHINERY. FOURTH TOPICAL REPORT. DEVELOPMENT AND TEST OF A HIGH-TEMPERATURE PROXIMITY PROBE FOR USE IN LIQUID SODIUM. Hoogenboom, I.; Kissinger, C. (Mechanical Technology Inc., Latham, N. Y.). Jun 1971. Contract AT(30-1)-3930. 129p. (MTI-71-TR-27). Dep. NTIS.

An inductance-type, proximity-probe system for measurement of bearing film thicknesses and shaft orbits in high-temperature, liquid-sodium environment has been developed, built, and tested. The probe system is designed to operate at temperatures up to 1200 F and gap range of 0.004" to 0.080", with good linearity over about three-quarters of the range, when using probe pairs connected in push-pull. The probes were tested extensively in both gas and sodium environments, culminating in a 684 hours continuous test in a temperature range of 1050 F to 1170 F. The probes operated stably, repeatedly and without undergoing performance changes. An electronic amplification and read-out system was specially designed for use with these probes. This electronic package was also developed, built and successfully utilized in the probe tests. (auth)

44729 (RT/EL-(69)7, Paper 6) USE OF ON-LINE COMPUTERS FOR NUCLEAR SPECTROSCOPY AND ACTIVATION MEASUREMENTS. Arcipiani, L.; Giannini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 42p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

The use of on-line computers for nuclear-spectroscopy measurements is considered. The physical nature of the problem is treated, and criteria for deciding whether an on-line computer is needed are discussed. Possible solutions to the problem, using computers of various sizes, are drawn from several installations in operation. A detailed description of two CNEN computer systems is given; these are a PDP-9 computer, dedicated to a single nuclear spectroscopy experiment, and a 360/30, working in multiprogramming, linked to experimental equipment for activation measurements. (R.W.R.)

44730 (SWRHL-502-r) DATA ACQUISITION AND ANALYSIS SYSTEM FOR EMERGENCY ENVIRONMENTAL SURVEILLANCE. Snelling, R. N. (Western Environmental Research Lab., Las Vegas, Nev.). [Mar 1971]. 30p. (CONF-710705-4). Dep. NTIS.

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

A computer-based system for the rapid analysis of large num-

bers of environmental samples is described. The functional breakdown of the system includes sample control, gamma analysis, air sample analysis, chemistry data analysis, and data management. (W.H.K.)

44731 (UCRL-51082) WEDS IN EUROPE. Berndt, C. W.; Goodman, R. A.; Kooshian, C. H.; O'Connell, L. G. (California Univ., Livermore. Lawrence Radiation Lab.). Jun 1971. Contract W-7405-eng-48. 66p. Dep. NTIS.

A computer driven display system, WEDS MOD II prepared for evaluation in the field by USAREUR, 7th Army in Germany was delivered and installed. The process of preparing the equipment is described as well as the installation in Europe and the training program conducted for operators and maintenance personnel. An estimate of the success of the operation is made in view of the different characteristics of LRL and the military. (auth)

44732 (UNC-5252) CONTINUOUS ELECTROCHEMICAL METER FOR MEASUREMENT OF HYDROGEN IN SODIUM. Phase I Final Report, Concept Feasibility. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Mar 1970. Contract AT(30-1)-3908. 149p. Dep. NTIS.

The initial phase of a program to develop a continuous reading electrochemical meter for on-line measurement of hydrogen in liquid sodium systems is described. The design and construction of test sensors, screening of candidate electrolytes and other materials of construction by testing in a gas environment, further testing and evaluation of promising sensors in sodium, and comparison of sensor performance with theoretical behavior based on a simple concentration cell model are discussed. (W.H.K.)

44733 SATURATION EFFECTS IN CYCLOTRON RESONANCE OSCILLATORS. Rowe, J. F. Jr. (Cornell Univ., Ithaca, N. Y.). Int. J. Electron.; 31: No. 1, 33-45(Jul 1971).

The results of a large signal analysis of a cyclotron resonance oscillator are presented. A digital computer was used to obtain numerical results for a particular set of parameters. The model adopted for the oscillator assumes a spiralling filamentary electron beam interacting with a rectangular cavity. Both the gain and saturation mechanisms for a cyclotron resonance oscillator are discussed. (auth) (UK)

44734 LEHRBUCH DER NUKLEARELEKTRONIK. (Textbook on Nuclear Electronics). Weinzierl, P.; Drosg, M. Vienna; Springer-Verlag (1970). 518p. $32.80.

The textbook originates from lectures presented at the University of Vienna. In chapter one, fundamental principles of radioactivity and measurements are discussed as well as measurements of ionizing radiation. The second chapter treats the fundamentals of electronic units. Chapter 3 summarizes the most essential electronic components. In chapters 4 and 5, both analogous and digital electronics are discussed in detail. Chapter 6 treats special problems of nuclear electronics and appropriate measuring devices. 600 references are given. (H.B.G.)

44735 K-FLUORESCENCE X-RAYS: A MULTI-USE TOOL FOR HEALTH PHYSICS. Kathren, R. L.; Rising, F. L.; Larson, H. V. (Battelle-Northwest, Richland, Wash.). Health Phys.; 21: No. 2, 285-93(Aug 1971).

Therapeutic or industrial x ray generators can be simply and effectively adapted to the production of K fluorescence radiation by impinging the primary beam onto an appropriate secondary target. The technique of producing a secondary beam of large diameter with virtually any energy below 100 keV is described. Typical spectra show the beam to be composed almost exclusively of K characteristic radiation, with less than 2% of the total flux attributable to scattering or L fluorescence if appropriate filtration is used. The essentially monoenergetic beams are extremely valuable for energy dependence studies of dosimeters and detectors of all types, providing a more intensive study of the response in the 8 to 100 keV_{eff} region than is possible with conventional x ray sources. By use of a radiator with Z near 40, the photon spectrum from ^{239}Pu can be simulated without the necessity of using highly radiotoxic materials. Similar mock spectra can be achieved for ^{241}Am and ^{243}Am. The potential application of this device to radiological standardization is also discussed. (auth) (UK)

44736 METHODS OF MEASURING THE PERFORMANCE OF AN ELECTROSTATIC SPECTROMETER. Roy, D.; Carette, J.-D. (Univ. Laval, Quebec). Rev. Sci. Instrum.; 42: No. 8, 1122-7(Aug 1971).

The methods used to measure response and performances of an electrostatic spectrometer with an identical apparatus are studied in the case of the 127° cylindrical spectrometer by means of a method of calculation of the electron energy distribution. The distribution given by the monochromator is calculated and its analysis with the identical analyzer is simulated. The three usual methods of analysis are found to give inaccurate results not only for the widths of the energy distribution but also for its profile. It is shown that because of the inherent angular dispersion of the analyzer, it is necessary to carry out the analysis of the beam by narrow angular slices in order to recover the exact profile of the energy distribution yielded by the monochromator. (auth)

44737 COMBINED ENERGY AND ANGLE ANALYZER FOR SCATTERED ELECTRONS. Harting, Erik (Univ. of New South Wales, Kensington, Australia). Rev. Sci. Instrum.; 42: No. 8, 1151-6(Aug 1971).

An instrument is described which permits energy analysis, by electrostatic deflection, of any of six beams of scattered electrons. In the particular design discussed, the beams define scattering angles between 40 and 140°, in 20° intervals. Various parameters of electron trajectories, including effects of small magnetic fields, have been computed and design criteria for optimum angular and energy resolution are presented. (auth)

44738 GENERATOR FOR NANOSECOND CHARGE PULSES. Firth, J. M. (National Research Council of Canada, Ottawa). Rev. Sci. Instrum.; 42: No. 8, 1253-5(Aug 1971).

The circuit described delivers small current pulses from a high impedance source. The 20 nsec pulse enables the circuit to be used as a charge source, variable from 10^{-15} to $> 10^{-12}$ C/pulse, for testing charge sensitive amplifiers. Rates up to 10^7 pps are available. An external gate input enables pulse bursts to be obtained, and single shot operation is possible, either manually or remotely triggered. A simple calibration check can be used. (auth)

44739 NEW APPARATUS FOR STUDYING EXCITATION IN ION-ATOM COLLISIONS AT LOW ENERGY USING THE ION-PHOTON COINCIDENCE METHOD. Vassilev, G.; Baudon, J.; Rahmat, G.; Barat, M. (Faculte des Sciences, Orsay, France). Rev. Sci. Instrum.; 42: No. 8, 1222-7(Aug 1971).

A new apparatus is described whose purpose is the study of ion-atom excitation processes. A single photon emitted by the excited target atom is detected in coincidence with the ion scattered at a given angle. Preliminary results are given for the He^+-He collision at 300 eV and scattering angle from 6 to 15° with excitation of the 3^3P-2^3S line (3889 Å). (auth)

44740 TELEPHOTO LENSES FOR X-RAY TELESCOPES AND NEUTRON CAMERAS. Wolter, Hans (Univ., Marburg, Ger.). Z. Angew. Phys.; 31: No. 3, 152-5(1971). (In German).

Among the optics for X-rays, several types called second order X-ray optics distinguish themselves by their special qualification for the application as X-ray telescopes on satellites and space stations. They contain a combination of collecting and scattering areas (telephoto lenses) the construction length of which from the outside to the picture plane is smaller than their focal length. Simultaneously, the angles of the emerging rays with the axis grow small, which is convenient for a good fulfillment of the aplanasy condition. Therefore, proceeding from second order areas, one is able to attain by retouching under optical control with the Schlieren or phase contrast method good correction conditions. For neutron cameras second order systems offer the advantage of a smaller construction length and smaller mutual influence of the magnetic fields. (auth)

44741 FAST LINEAR GATE. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 94: No. 3, 525-31(1971).

A dc-coupled linear gate developed for measurements in nuclear physics is presented. It is characterized by a large transmission bandwidth and a fast switching from one state to the other. By using a monolithic integrated circuit as the gating element, a high dc stability and a suppression of switching transients are obtained. A second integrated circuit operates as a gate-pulse generator with variable pulse width. The linear gate output stage is able to deliver ±10 V into 50 Ω. (auth)

44742 APPARATUS FOR $\beta\gamma_{cp}$-CORRELATION MEASUREMENTS USING THE COMPTON BACKSCATTERING METHOD IN MAGNETIZED IRON. Schmidt, V.; Goder, G.; Wallek, L. (Institut fuer Kernphysik, Muenster, Ger.). Nucl. Instrum. Methods; 94: No. 3, 521-3(1971).

An apparatus for the measurement of $\beta\gamma_{cp}$-correlations is described. The Compton backscattering method is used in order to eliminate the possible influence of Rayleigh scattering. Beta particles are detected by a silicon surface-barrier detector, and γ rays, by a Ge(Li)-detector. The characteristic values of the polarization analyzer are determined. (auth)

XUM

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 46315.

44743 (SC-DC-713695) NEW PROPAGATION DELAY TIME BRIDGE FOR THE STUDY OF DISPLACEMENT DAMAGE EFFECTS IN BIPOLAR TRANSISTORS. Sullivan, W. H.; Weinlein, J. H. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 40p. (CONF-710709-2). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Durham, N. H. (20 Jul 1971).

An entirely new bridge circuit for the measurement of the junction transistors total propagation delay time is described. Unlike previous methods, this bridge is calibrated in time units and thus it provides a direct readout of delay time. An experiment to evaluate the bridge as a one-test acceptance screening tool in neutron hardness assurance programs is described. Finally, a general discussion of propagation delay time and its interpretation is presented as an appendix. (auth)

44744 (SC-DC-713706) DESIGNING ULTRAHARD BIPOLAR TRANSISTORS. Gwyn, C. W.; Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 35p. (CONF-710709-4). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Durham, N. H. (20 Jul 1971).

Calculations are presented for a bipolar transistor which indicates the relative importance of the device regions in establishing the neutron tolerance. For conventionally diffused profiles with a fixed set of device parameters, the calculations indicate that an optimum base width may occur which will yield the maximum neutron hardness. The analysis indicates that the neutron hardness can be increased substantially by using a device profile with a shallow, abrupt emitter and a narrow base region. Devices utilizing these criteria are extremely tolerant to neutron irradiation and show a current gain greater than 10 after a neutron fluence of 10^{16} n/cm^2 (E > 10 keV). This represents an order of magnitude increase in device hardness over those presently available. (auth)

44745 (SC-DC-713707) NEUTRON-PRODUCED TRAPPING CENTERS IN JUNCTION FIELD-EFFECT TRANSISTORS. Gregory, B. L.; Naik, S. S.; Oldham, W. G. (Sandia Labs., Albuquerque, N. Mex.). Jul 1971. 38p. (CONF-710709-6). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Durham, N. H. (20 Jul 1971).

The junction field effect transistor has been employed to study trapping centers introduced in silicon by fast neutron irradiation. Extensive measurements have been made of both the static and dynamic characteristics of irradiated devices. The degradation and annealing of G_{MSAT}, I_{DSS}, and V_{PO} have been explored in both n and p channel devices, as a function of neutron fluence and dopant concentration. The results of isochronal annealing measurements are compared to similar measurements in bulk silicon, and indicate that the parameter annealing above room temperature is dependent on phosphorous concentration in the n-type devices. The trapping center effects on small signal transconductance and large signal pulse response are characterized and the data is utilized to determine ionization energy values for the dominant traps. In n-type, trap energy levels of $E_c - 0.41$ and $E_c - 0.49$ eV are obtained, and in p-type an energy level of $E_v + 0.32$ eV is observed. (auth)

44746 (SC-DC-713804) CIRCUIT APPLICATIONS OF TRANSIENT ANNEALING. Sander, H. H.; Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). Jul 1971. 19p. (CONF-710709-5). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Durham, N. H. (20 Jul 1971).

A method is presented for predicting transistor annealing factors from simple electrical measurements on a device. A nomograph has been derived from experimental data which relates annealing factors at any time after exposure to the electron density in the emitter-base space-charge region. The electron density in this region is related to V_{BE} in a device by a simple expression, presented graphically. The effects of transient annealing are investigated for two typical circuit situations (power inverter circuits and logic circuits) where devices may be OFF during irradiation and subsequently required to turn-on. The Darlington circuits utilized in typical power-inverters prolong the annealing, if OFF when exposed. The propagation delay of a NAND gate series pair is increased considerably at early times after a neutron exposure. This additional delay can result in reduced pulse width or lost pulses. (auth)

44747 (SC-DC-714161) NEUTRON ENERGY DEPENDENCE OF DAMAGE TO SEMICONDUCTOR DEVICES. McKenzie, J. M. (Sandia Labs., Albuquerque, N. Mex.). Jul 1971. 15p. Dep. NTIS.

An experimental neutron standard remote from the resonance region is proposed, and an experimental procedure is developed to compare the damage effectiveness of an unknown spectrum to the standard. A systematic set of experiments on semiconductor devices is developed to provide damage equivalences for the effects of different neutron spectra on various device parameters. A carrier generation lifetime damage constant, a carrier removal damage constant, and a damage constant of an operating majority carrier device were determined for different neutron spectra relative to the damage produced by 14.1 MeV neutrons. (W.H.K.)

44748 (SC-RR-710378) TRANSIENT AND PERMANENT RADIATION EFFECTS IN GUNN AND IMPATT OSCILLATORS. Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 39p. Dep. NTIS.

An experiment designed to observe rate effects in Gunn and IMPATT diodes is described. The irradiations were performed using the Sandia SPR-II pulse reactor which produces rates as high as $\dot{\gamma} = 4 \times 10^8$ rads/sec and $\dot{N} = 3 \times 10^{18}$ neutrons $\cdot$ cm$^{-2} \cdot$ sec^{-1}. The Gunn diode was found to be essentially rate-insensitive at the rates listed above; however, large amounts of permanent damage were incurred by these diodes at relatively low (10^{13} nvt) levels. The IMPATT diodes were found to be rate-sensitive at the above mentioned rates; however, they recovered shortly after the radiation pulse and showed almost no permanent damage out to levels of 10^{15} nvt. The reasons for the observed differences in the rate sensitivities of these devices are explained. (auth)

44749 CHANGE IN ELECTRIC CONDUCTIVITY OF NONLINEAR SILICON CARBIDE RESISTORS WITH GAMMA RADIATION. Kashukeev, N.; Ribarov, St.; Krezhov, K.; Todorov, V. (Physical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 1, 35-7(1971). (In Russian).

Black p-type SiC resistors were subjected to ^{60}Co gamma radiation (226 rad/sec) in order to determine possible effects on their conductivity. Both irradiation and subsequent measurements were conducted at 293°K and 78°K. The results of this testing program showed that as a result of radiation dosages of 10^4 to 10^5 rad, the conductivity of 82% of the resistors increased, 7% decreased, and the remainder were practically unchanged. It was noted that the percentage change was generally about 10%, thus for many applications of these components this amount of radiation-induced change could be neglected. (K.S.W.)

44750 RELAXATION OF SELENIUM RECTIFIERS IN RESPONSE TO X-IRRADIATION AND REVERSE CURRENT FLOW. Loiko, V. I. (Belorussian State Univ., Minsk). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 124-5(1971). (In Russian).

During irradiation of Se rectifiers at 4.3 R/sec with x-rays, and in the absence of applied voltage, fatigue phenomena were observed. When voltage was applied to the rectifiers, the current decreased with passage of time from 8 μA to 1 μA. Temperature effects were also observed with the aid of a thermocouple. It is proposed that the determining mechanism of current passage through the rectifiers is the Frenkel volume effect of ionization at the heterojunction Se–CdSe. (K.S.W.)

44751 ELECTRICAL ENGINEERING PROPERTIES OF PORCELAIN EXPOSED TO γ-RADIATION. Kostyukov, N. S.; Talyzin, V. V.; Muminov, M. I.; Zil'berman, M. I. This paper was summarized in At. Energ. (USSR); 29: No. 1, 39(Jul 1970) as paper No. 407/5490. (In Russian).

Changes in the parameters ρ, tan δ, ϵ, and temperature of electrical-engineering porcelain in response to exposure to gamma radiation at various exposure rates are discussed. The frequency dependence of tan δ and ϵ was measured from 500 Hz to 20 kHz. The behavior of cable insulation and the solid-state filler for the measuring cell was studied to estimate the error in the measurements. Analysis shows that a decline in the value of ρ and a rise in the values of tan δ and ϵ are not limited to the effects of radiation heating but are of a more complex nature, even though these variables do respond to temperature changes. After the material was removed from the radiation field, the values of ρ, tan δ, and ϵ returned to the values recorded before exposure. (R.W.R.)

44752 EFFECT OF REACTOR RADIATION ON EQUIPMENT WITH METAL OXIDE SEMICONDUCTOR STRUCTURE.

Popov, V. D. Izv. Vyssh. Ucheb. Zaved., Radioelektron.; 14: No. 4, 458-60(Apr 1971). (In Russian).

The effect of reactor radiation on metal oxide semiconductor (MOS) structures with SiO_2 films 200 to 400 Å thick was investigated—specifically capacitors with a metal-SiO_2-Si arrangement. Radiation damage resulting from internal reactor exposure was evaluated by measurement of the volt-farad characteristic (VFC) of the MOS 10 to 20 days after exposure. The neutron spectrum at the two locations used had coefficients K_E^f = 2.23 and 5.26. The results showed that MOS devices irradiated at the K_E^f = 2.23 location in the reactor showed a VFC drift toward the negative direction. In contrast, MOS devices exposed at the K_E^f = 5.26 location showed a VFC drift toward the positive voltage direction. The volt-ampere characteristic drift of MOS-devices was independent of reactor zone location, however. The theoretical reasons for these observations based upon the behavior of the SiO_2 film in the semiconductors are discussed. (K.S.W.)

XUM

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

44753 DETECTION OF ANTIBODY TO HEMOCYANIN BY DIRECT SOLID-PHASE (POLYSTYRENE) RADIOIMMUNOASSAY AND GEL FILTRATION. Kotoulas, Angeliki O.; Moroz, Leonard A. (McGill Univ., Montreal). J. Immunol.; 106: No. 6, 1630-40(Jun 1971).

A sensitive, relatively simple method is described for the direct solid-phase radioimmunoassay of antibody to a macroglobulin antigen, keyhole limpet hemocyanin (KLH). Antibody is adsorbed to polystyrene tubes (antibody-binding phase), reacted with ^{125}I-KLH (antigen-binding phase) and excess ^{125}I-KLH removed by washing, the residual radioactivity providing a measure of antibody activity. The sensitivity of the method (5 to 10 ng antibody protein) is comparable to other primary antibody assays, and is markedly dependent on ionic strength and total protein concentration during the antibody-binding phase. The assay is equal to or slightly less sensitive than passive hemagglutination for detecting 19S antibody, and consistently more sensitive for detecting 7S antibody. A method of similar sensitivity is also described for the detection of anti-KLH antibody by gel filtration on agarose columns. Both methods are potentially applicable to the detection of antibody to other, particularly macroglobulin, antigens. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 44801, 44802, 44888, 44948, and 44950.

44754 HAEMATOLOGICAL CONSEQUENCES OF RADIOISOTOPE INCORPORATION WITH PARTICULAR REFERENCE TO PLUTONIUM, THORIUM, RADIUM, IRON, AND GOLD. Vaughan, Janet (Churchill Hospital, Oxford). pp 215-42 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

A review is presented of ^{239}Pu with regard to pattern of distribution in the bone marrow, dosimetry, and blood dyscrasias. Studies on anemia induced in beagles and leukemia induced in rats by ^{239}Pu are reviewed. A review of ^{232}Th is presented with emphasis on the use of Thorotrast as a contrast medium. The dosimetry of α particles, β particles and γ radiation following administration of Thorotrast by several different routes is reviewed. In a review of blood dyscrasias resulting from Thorotrast, it is pointed out that hematopoietic tissues are at risk from deposits of thorium dioxide and its decay products in the marrow; from deposits of thorium dioxide and decay products on bone surfaces; and from translocation of ^{224}Ra and ^{228}Ra and ^{228}Th from decay of thorium dioxide deposits in tissues elsewhere in the body. Isotopes of radium, ^{226}Ra, ^{228}Ra, and ^{224}Ra, are reviewed with regard to tissue distribution, dosimetry, and blood dyscrasias. Isotopes of iron, ^{59}Fe, ^{52}Fe, and ^{55}Fe, are reviewed with regard to iron absorption and utilization, measurement of blood loss, plasma iron turnover, and surface counting of ^{59}Fe. Hematological effects following the use of colloidal ^{198}Au for bone marrow scanning are discussed; colloidal ^{199}Au was not found to be practical. (H.L.W.)

44755 EFFECT OF IONIZING RADIATION ON THE PASSAGE OF RADIOPROTECTORS WITH THE URINE IN RATS. Golubentsev, D. A.; Merkina, T. N.; Mordukhovich, V. V.; Titov, A. V. Farmakol. Toksikol.; 33: No. 5, 607-10(Sep-Oct 1970). (In Russian).

The administration of β-mercaptoethylamine (MEA), cystamine, or cystaphos in radioprotective doses to non-irradiated rats produced a sharp rise of non-protein thiols in the urine, which was caused by the appearance of MEA. When cystamine was administered, the amount of MEA passed with the urine was twice as low as when MEA itself was introduced. Whole-body irradiation of rats in a dose of 700 R (LD-100/30) 5 to 10 min after administration of the protective agents under study resulted in a declined MEA excretion, this pointing to their metabolism changes under the effect of ionizing radiation. (auth)

44756 RADIUM IN AQUATIC FOOD CHAINS: RADIUM UPTAKE BY FRESH WATER ALGAE. Havlik, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Res.; 46: No. 3, 490-505(Jun 1971).

Accumulation of ^{226}Ra was studied in four species of green algae; Ankistrodesmus falcatus var. acicularis, Chlorella vulgaris, Coelastrum cambricum, Chlamydomonas simplex and two species of blue-green algae, Microcystis pulverea and Anacystis nidulans. Algae were cultivated in inorganic culture. Radium was added in amounts of 1 μCi/l, 0.1 μCi/l, and 0.01 μCi/l. After 14 days the amount of radium in the medium in dead and living algal cells, and in washes from the algae was determined at intervals using a liquid scintillation counter. There were two characteristic types of responses to radium. The first was shown by Ankistrodesmus falcatus var. acicularis and Coelastrum cambricum. From 50 to 80% of the radium was absorbed within the cells and the amount absorbed was proportional to the length of exposure. In the second type of response, typical of the other four species of algae, radium was mostly adsorbed on the cell surface (25 to 50%) and only 1 to 8% was present within the cells. The highest accumulative factor was reached after 24 hrs of exposure. The accumulative factor of the radium absorbed by the algae was inversely proportional to concentration of radium in the medium. Radium uptake was dependent on the species of algae, the concentration of radium in the medium, the growth rate of the algae and their physiological condition, and the period of exposure. The factors responsible for radium accumulation were adsorption, absorption, and incorporation, in that order of importance. (auth)

44757 STIMULUS-SECRETION COUPLING OF GLUCOSE-INDUCED INSULIN RELEASE. IV. THE EFFECT OF VINCRISTINE AND DEUTERIUM OXIDE ON THE MICROTUBULAR SYSTEM OF THE PANCREATIC BETA CELL. Malaisse-Lagae, F.; Greider, M. H.; Malaisse, W. J.; Lacy, P. E. (Washington Univ., St. Louis. (Univ., Brussels). J. Cell Biol.; 49: No. 2, 530-5(May 1971).

Microtubules have been previously recognized in pancreatic beta cells. A clue to the role played by the microtubules in the process of insulin secretion was investigated. Rat pancreatic tissue was exposed, in vitro, to heavy water (a microtubule-stabilizer) and to vincristine (a mitotic spindle-inhibitor). Both agents failed to affect the general ultrastructure of the beta cells. Numerous microtubules were found in the beta cells after exposure to heavy water. Prolonged incubation in the presence of vincristine provoked the disappearance of microtubules and the massive precipitation of microcrystalline material, presumably derived from the microtubular protein. Less abundant crystalline deposits were also disclosed in acinar and ductular epithelial cells. Both D_2O and vincristine inhibited glucose-induced insulin secretion, and their effect on the beta cell ultrastructure seemed to be limited to the microtubular system. These data afford additional support to the concept that the microtubular system of the beta cells plays an integral role in the process of insulin secretion. (auth)

44758 ^{90}Sr IN HUMAN BONE, APRIL–JUNE 1970. I. Radiol. Health Data Rep.; 12: No. 4, 225-8(Apr 1971).

To obtain data on the content of ^{90}Sr in man by age and geographical region, the Public Health Service began collecting human bone specimens in late 1961. Since older age groups have proven to have low, age independent ^{90}Sr bone content, the target population included children and young adults up to 25 yrs of age. The results for ^{90}Sr in individual bones from persons dying during April through June 1970 are presented. (E.E.H.)

44759 RADIOPATHOLOGY OF ^{241}Am. II. UPTAKE IN THE DEVELOPING TEETH OF RATS. Hammarstroem, Lars; Nilsson, Agnar (Kungliga Veterinarhogskolan, Stockholm. Forsvarets Forskningsanstalt, Stockholm. Karolinska Institutet, Stockholm). Acta Radiol., Ther., Phys., Biol., 9: 609-17(1970).

Young rats were injected intravenously with ^{241}Am citrate solutions and investigated at different times by whole-body autoradiography and microradiography. The techniques are described and the findings discussed in detail. (auth) (Sweden)

44760 COMPARATIVE STUDY OF DISTRIBUTION OF INJECTED ^{65}Zn IN THE MANDIBULAR CONDYLE AND OTHER TISSUES IN RAT AS DETERMINED BY GAMMA SCINTILLATION. Bergman, Bo (Umea Univ., Sweden). Acta Radiol., Ther., Phys., Biol.; 9: 577-95(1970).

The distribution of ^{65}Zn in young and adult rats was studied by scintillation measurements. The most rapid turnover was observed in pancreas, liver, kidney, and spleen. In hard tissues and hair, ^{65}Zn was deposited more slowly. The incisors steadily increased their ^{65}Zn concentration over the experimental period in both age groups. Of the skeletal tissues, the mandibular condyle showed a more rapid turnover than mandibular bone, tibia diaphysis, or tibia epiphysis. (auth) (Sweden)

44761 PRESENCE OF RADIOTOXINS IN THE MILK OF COWS WITH CHRONIC RADIATION SICKNESS. Sypin, V. D.; Donskaya, G. A. (All-Union Inst. of Experimental Veterinary Science, Moscow). Radiobiologiya; 11: No. 2, 230-4(Mar-Apr 1971). (In Russian).

In an experiment on 25 white rats of the Wistar line it was found that the milk obtained from cows with chronic radiation sickness, which had received strontium-90 with their feed for long periods, and subjected to deactivation on the ion exchange resin KU-2-8ch, exhibited a more pronounced biological effect on rats in comparison with milk artificially treated with strontium-90. This was manifested in a decrease in the rate of growth of the animals, anemia, leukopenia, the appearance of pathologically changed forms of leukocytes, and an impairment of the reproductive function. A hypothesis is advanced on the responsibility for these changes not only of ^{90}Sr but also of radiotoxins, both lipid and protein, formed in the irradiated cow organism and apparently excreted with the milk. (tr-auth)

44762 INVESTIGATION OF THE STATISTICAL DISTRIBUTION OF ^{144}Ce IN THE ORGANS AND TISSUE OF HYDROBIONTS. Chugunov, V. V.; Podgurskii, A. M.; Cherenkova, G. A.; Lyapin, E. N. Radiobiologiya; 11: No. 2, 298-301(Mar-Apr 1971). (In Russian).

The statistical probabilities of the distribution of cerium-144 in the organs and tissues of freshwater fishes, floating fern (Salvinia), organic material (polyvinyl chloride), and water in the aquarium were studied under the conditions of aquarium experiments. It was established that the forms of the distribution functions differ and depend on the biological peculiarities of the investigated objects. (tr-auth)

Radiation Effects

Refer also to abstracts 44391–44393, 44789, 44809, and 44960.

44763 PRIMARY CHANGES IN THE DNP OF THE CHROMATIN OF THE RAT THYMUS AFTER GAMMA IRRADIATION. Strazhevskaya, N. B.; Troyanovskaya, M. L. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya; 11: No. 1, 17-21(Jan-Feb 1971). (In Russian).

The change in the state of rat thymus DNA as a function of dose and time after γ irradiation of the animals was studied in experiments in vivo. The effect was judged according to the amount of DNA that passed into interphase after phenol deproteinization of DNP at the phenol-water interface. It was shown for the first time that after irradiation of rats at a dose of 1 kR, a distinct effect was observed (137%), that increased with the dose. The dependence of the effect on DNP upon time after γ irradiation of the rats (1 kR) was complex and consisted of three stages: an increase in the effect (first 15 min)—the direct action of radiation; a false return to normal (up to 2 hrs)—the compensatory stage; a decrease in the effect (after 2 hrs)—secondary enzymatic processes. (tr-auth)

44764 ACTIVITY OF PHOSPHORYLATION ENZYMES OF THYMIDINE AND THYMIDYLIC ACID IN BONE MARROW OF IRRADIATED RABBITS. Elkina, N. I.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 22-7(Jan-Feb 1971). (In Russian).

The activity of the phosphorylation enzymes of thymidine and TMP to TTP in the bone marrow of rabbits was studied for a period of six days following γ irradiation at doses of 500 and 1000 R. In the first hr following irradiation, the activity of the enzymes was almost unchanged. An appreciable decrease in the activity of kinases per mg protein was detected beginning at 2 hrs following irradiation at a dose of 1000 R; the lowest data were obtained 8 hrs after the action of radiation (about 11% of the norm). The amount of TTP synthesized, calculated per myelokaryocyte was 28.5 to 34.8% of the control at this period, while after one and three days it exceeded the control data by 1.5- and 6-fold, respectively. Under the action of 500 R, the kinase activity changed to a lesser degree than after irradiation at a dose of 1000 R. (tr-auth)

44765 STUDY OF THE SEQUENCE OF PYRIMIDINE OLIGONUCLEOTIDES AND THE PHYSICOCHEMICAL PROPERTIES OF THE DNA OF COTTON SEEDLINGS IN THE NORMAL STATE AND AFTER GAMMA IRRADIATION OF SEEDS. Ibragimov, A. P.; Divavin, I. A.; Aripdzhanov, Sh. A. Radiobiologiya; 11: No. 1, 28-31(Jan-Feb 1971). (In Russian).

The effects of γ irradiation on certain characteristics of the primary and secondary structure of the labile DNA of cotton seedlings were investigated. A change in the composition of the bases, the frequency of alternation of pyrimidine oligonucleotides, the degree of polymerization, as well as certain quantities characterizing the process of DNA denaturation, were demonstrated. (tr-auth)

44766 ACTIVATION OF LYSINE AND AMINOACYLATION OF tRNA UNDER THE ACTION OF LYSYL-tRNA SYNTHETASE FROM THE LIVERS OF RATS SUBJECTED TO WHOLE-BODY X IRRADIATION. Khanson, K. P.; Orlova, T. A.; Petrova, L. D.; Shutko, A. N. (Central Roentgenoradiological Scientific Research Inst., Leningrad). Radiobiologiya; 11: No. 1, 32-6(Jan-Feb 1971). (In Russian).

The kinetic principles of the activation of lysine and the transfer of the activated amino acid to tRNA under the action of lysyl-tRNA synthetase, isolated from the livers of x-irradiated (800 and 1500 rad) rats, were studied. It was shown that whole-body x irradiation leads to a substantial suppression of the activity of the enzyme. The nature of the changes in the kinetic parameters of the reaction studied permits us to assume that the leading role in the inactivation of lysyl-tRNA synthetase is played by the mediated action of radiation. (tr-auth)

44767 RADIATION DAMAGE TO THE PROTEIN COMPONENT OF MYOGLOBIN OF IRRADIATED ANIMALS. Sukhomlinov, B. F.; Datskiv, M. Z.; Khmil, M. V. (Lvov State Univ.). Radiobiologiya; 11: No. 1, 37-41(Jan-Feb 1971). (In Russian).

The influence of x rays on the protein component of myoglobin, isolated from the muscles of dogs irradiated at a dose of 600 R, was investigated. It was established that after irradiation of the animals, the amino acid composition, topography, and number of peptides of tryptic hydrolyzates, as well as the absorption curves in the infrared region of the spectrum of the proteins studied, were changed. (tr-auth)

44768 INVESTIGATION OF THE BIOSYNTHESIS OF HISTONES IN THE LIVER AND SPLEEN OF IRRADIATED ANIMALS. Paskevich, I. F.; Ishkhanova, M. A.; Likhoded, V. S.; Paskevich, L. V. (Kharkov Scientific Research Inst. of Medical Radiology). Radiobiologiya; 11: No. 1, 42-7(Jan-Feb 1971). (In Russian).

The biosynthesis of the histones of the liver and spleen of white rats was studied 2, 24, 48, and 72 hrs after x irradiation at a dose of 800 R. It was established that irradiation induced an increase in histone synthesis in the liver at all periods of the experiment; these changes were most distinctly observed 48 hrs after irradiation. In the spleen there was a sharp drop in the specific radioactivity (^{14}C) of the histones at all the periods studied, with the exception of 48 hrs, when a tendency for normalization of these indices was observed. In both organs the synthesis of the lysine-rich fraction of the histones was more sharply changed in comparison with the arginine fraction. (tr-auth)

44769 MECHANISM OF THE RADIATION INHIBITION OF α-AMYLASE SYNTHESIS IN BARLEY SEEDS. Kuzin, A. M.; Tagi-Zade, Z. (Inst. of Biophysics, Pushchino, USSR). Radiobiologiya; 11: No. 1, 124-7(Jan-Feb 1971). (In Russian).

The molecular mechanism of radiation inhibition of α-amylase synthesis in cells of the aleuron layer of barley was investigated. At a dose of 40 kR, complete inhibition of synthesis can be entirely restored by the addition of an effector—gibberellic acid, which indicates a conservation of the genetic system coding the synthesis of α-amylase at this dose. Only at larger doses (100 kR) is this system disrupted, and it ceases to respond to the added effector. (tr-auth)

44770 INFLUENCE OF RADIOTOXINS ON THE CATALYTIC AND ALLOSTERIC PROPERTIES OF PHOSPHOFRUCTOKINASE. Ermekova, V. M.; Veksler, A. M.; Kuzin, A. M. (Inst. of Biophysics, Pushchino, USSR). Radiobiologiya; 11: No. 1, 128-30 (Jan-Feb 1971). (In Russian).

The influence of water-soluble radiotoxins (RT) on the catalytic and allosteric functions of a pure crystalline enzyme, phosphofructokinase (PFK), was investigated. It was shown that RT in large concentrations are capable of inhibiting the catalytic activity of PFK, just like large doses of irradiation. In low concentrations, which no longer influence the catalytic properties of the enzyme, these substances inhibit the allosteric function of PFK, which leads to their activation of the enzyme in the presence of an allosteric effector ATP. It is concluded that there is a similarity between the action of the investigated RT and the effect of γ irradiation on PFK. (tr-auth)

44771 INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON DNA BIOSYNTHESIS IN THE MITOCHONDRIA OF THE INTACT AND REGENERATING RAT LIVER. Khanson, K. P.; Ivanova, L. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya; 11: No. 1, 131-4 (Jan-Feb 1971). (In Russian).

A comparison was made of the nature of the effects of whole-

XUM

body X irradiation on the biosynthesis of mitochondrial and nuclear DNA of the regenerating rat liver, evaluated according to the rate of incorporation of ^{3}H-thymidine. The animals were irradiated at a dose of 500 rad 6 hrs after partial hepatectomy, which corresponds to the early G_1 phase of the cellular cycle in the regenerating liver. It was shown that the influence of X rays leads to a suppression of the synthesis of both types of DNA; an interrelationship is noted between the initial level of incorporation of ^{3}H-thymidine into DNA and the radiosensitivity of its biosynthesis. (tr-auth)

44772 ^{60}Co γ-RADIOLYSIS OF AQUEOUS PAPAIN SOLUTIONS: REPAIR AND PROTECTION BY CYSTEINE. Gaucher, G. M.; Mainman, Barbara L.; Thompson, Gail P.; Armstrong, D. A. (Univ. of Calgary, Alberta). Radiat. Res.; 46: No. 3, 457-75(Jun 1971).

Earlier observations that the cysteine proteinase, papain, exhibits a high radiosensitivity and that a large percentage of the inactivation is repaired by cysteine, were confirmed. The radiosensitivity of Papain was demonstrated by dose-inactivation plots and by total inactivation yields (G-values) in the range 2 to 6 for solutions saturated with N_2O, N_2, and air at 0°C. The assay of inactivated papain with and without a postirradiation preassay treatment with 3.6×10^{-4} M cysteine provided a means of assessing the degree of repairable and nonrepairable inactivation and indicated that 25 to 70% of the inactivated papain may be repaired depending upon the irradiation conditions chosen. At 30°C, the repair process was essentially complete in approximately 5 min. Cysteine present in the papain solution during irradiation eliminated both repairable and nonrepairable inactivation. From a comparison of the yields in N_2O and N_2 saturated solutions, it was concluded that e^-_{aq} caused primarily repairable inactivation while OH radicals were relatively inefficient in causing either repairable or nonrepairable inactivation. These and related observations are discussed in terms of the possible reactions of papain with e^-_{aq}, OH, O_2^-, and H_2O_2, and in terms of the known radiosensitivity and function of specific amino acid residues in papain. (auth)

44773 NUCLEIC ACID METABOLISM IN RAT THYMOCYTES X-IRRADIATED IN VITRO. Geraci, J. P.; Christensen, G. M.; Jackson, K. L. (Univ. of Washington, Seattle). Exp. Cell Res.; 65: No. 2, 368-76(1971).

The metabolism of nucleic acids in 1,000 R x-irradiated rat thymocytes was studied using radioactively labeled purine bases and pyrimidine nucleosides. Cells were examined for early radioinduced alterations in transport of base into the cell, base phosphorylation, incorporation of label into nucleic acids, and loss of radioactivity from nucleic acids of cells labeled prior to x ray exposure. A significant depression in the incorporation of ^{14}C-8-adenine into nucleic acids was detected within 1 hr of irradiation and this occurred prior to inhibition of label uptake in the acid-soluble pool, indicating that radiation does not initially inhibit base transport into the cell. Chromatographic separation of labeled adenine nucleotides showed that phosphorylation of ^{14}C-8-adenine was not blocked by x ray exposure. Inhibition of incorporation of ^{3}H-thymidine-CH_3 into DNA and of ^{14}C-2-uridine into RNA was observed but neither effect occurred immediately after irradiation. Radioactivity in DNA labeled prior to irradiation was not lost following irradiation, whereas a radioinduced loss of prelabeled RNA radioactivity was observed. The magnitude of the loss of label from RNA was related to the time interval between pulse labeling and subsequent x ray exposure. These data suggest that an early radioinduced biochemical lesion in the rat thymocyte involves inhibition of maturation of rapidly labeled RNA to stable RNA. (auth)

44774 ANALYSIS OF HUMAN KIDNEY CELL OXYGEN-ENHANCEMENT RATIOS FOR FAST-NEUTRON BEAMS AND A PREDICTION FOR NEGATIVE PION BEAMS. Curtis, Stanley B. (Univ. of California, Berkeley). Radiat. Res.; 46: No. 3, 557-79(Jun 1971).

A semiphenomenological theory was developed to estimate survival curves of human kidney (T-1) cells in vitro from irradiation by particle beams that produce broad LET distributions. Track segment data were used in the low LET range by a straightforward generalization. The heavy recoils ($Z > 2$) from nuclear interactions, however, were treated separately. The assumption was made that such recoils inside the cell nucleus inactivate and those outside do not. Calculated oxygen-enhancement ratios from 3- and 15-MeV monoenergetic neutron beams compared favorably with experimental results; thus the constancy of this ratio as a function of neutron energy was quantitatively understood. The survival curves, however, agreed less well with experiment, perhaps due to inadequate assumptions made for the inactivation cross sections of low energy protons, for which no experimental data are available. The oxygen-enhancement ratio in the peak dose region of a stopping π^- beam was calculated to be between 1.8 and 2.0, slightly higher than the values obtained for the neutron beams. It was concluded that the α particle component is very important in the 15-MeV neutron and stopping pion beams, both in producing inactivation and in depressing the oxygen-enhancement ratio. (auth)

44775 SEARCH FOR PHYSICO-CHEMICAL CHANGES IN SOLUBLE COLLAGEN EXTRACTED FROM SKIN OF IRRADIATED RATS. Dancewicz, Antoni M.; Jelenska, Maria M.; Rzepniewska, Dobroslawa (Inst. of Nuclear Research, Warsaw). Nukleonika; 15: No. 11-12, 815-22(1970).

Rat skin acid soluble collagen extracted from non-irradiated rats and rats that were irradiated with 900 rads of x radiation was checked for physicochemical changes ½, 24, and 72 hours after exposure. The viscosity and optical rotation of collagen solutions as well as their content of free amino groups and aldehyde groups were unchanged. Irradiation increased, however, the content of hexoses and changed the kinetics of polymerization of collagen solutions. These findings are interpreted as indicative of not yet recognized changes in the capacity of collagen to form new bonds which in turn may account for the acceleration of collagen aggregation in irradiated animals. (auth)

44776 SOME PECULIARITIES OF THE BEHAVIOR OF RADIOACTIVE AND STABLE STRONTIUM IN MEADOW BIOGEOCOENOSES. Antropova, Z. G.; Belova, E. I.; Vodovozova, I. G.; Baturin, V. A. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 2, 301-4(Mar-Apr 1971). (In Russian).

The results obtained showed that the content of strontium-90 in the grass of natural fodder areas depends chiefly on the nature and structure of the sod, the floral composition of the stand of grass, and to a lesser degree on the physicochemical properties of the soil. In the tenth year of the presence of strontium-90 in soil, its distribution among the components of meadow biogeocoenoses became analogous to the distribution of stable strontium. (tr-auth)

44777 ULTRAVIOLET IRRADIATION OF CYTOSINE NUCLEOSIDES IN FROZEN SOLUTION PRODUCES CYCLOBUTANE-TYPE DIMERIC PRODUCTS. Varghese, A. J.; Rupert, C. S. (Univ. of Texas, Dallas). Photochem. Photobiol.; 13: 365-8(Apr 1971).

The technique of isolation and the properties of cyclobutane-type dimeric products of ultraviolet irradiation are described. 200 ml samples of frozen cytidine and deoxycytidine solutions (2 mmoles/l) were irradiated for 1 hour, 20 cm from 6 15 W mercury vapour lamps, at a dose rate of 125 ergs/mm^2/sec. The products were separated by paper chromatography and quantitatively analyzed by using cytidine $-2-^{14}$C in some experiments. The reactions were reversed by exposure of the products in solutions (PH values 5, 2, and 12) to wavelengths from 230 to 280 nm. Ultraviolet absorption spectra were obtained, and from the absorption changes during irradiation, cross sections for monomerization and quantum yields were calculated. (UK)

Immunology

Refer also to abstracts 44828 and 44842.

44778 RADIATION EFFECTS ON THE IMMUNE SYSTEM. Duplan, J. F. (Institut du Radium, Paris). pp 135-46 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The following topics are discussed: effects of irradiation as a function of the time at which it occurs in relation to immunization; primary responses following injection of the antigen prior to and after irradiation; secondary response; effects of irradiation on immunological paralysis and tolerance; effects of irradiation on cellular immunity; delayed hypersensitivity; rejection of allogeneic grafts; immune reactions in radiation chimaeras; effects of irradiation on adoptive immunity; effects of irradiation on the reticulo-endothelial system, macrophages, lymphoid tissue, and lymphocytes; and prevention and restoration of immune reactions. (H.L.W.)

44779 MACROPHAGE–HISTIOCYTIC SYSTEM. Cross, Anne (Yliopiston Sero Bakt., Helsinki). pp 147-50 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The macrophage-histiocytic system is primarily concerned with the phagocytosis and degradation either of foreign material that enters the organism or of senile and damaged cells belonging to the organism itself. The system includes various kinds of cells with the common ability to process and eventually degrade and digest the ingested material. Two morphological characteristics

of these cells are linked to their phagocytic functions: intracytoplasmic vacuoles and lysosomes. Although endothelial and fibroblastic cells can ingest particles, it seems that most cells of the macrophage-histiocytic system belong to the monocyte series. The stem cell of the system is still a matter for discussion and the mature cells have attracted a large and confusing array of names. Most of the experimental work with irradiation has involved macrophages of the peritoneal cavity and lymph nodes. It is likely that the other cells of the macrophage-histiocytic system are affected in the same way by irradiation, but this is not certain. (auth)

44780 QUANTITATIVE EVALUATION OF THE HAZARDS INVOLVED IN TRANSFERRING FOREIGN CELLS AND TISSUES TO IMMUNOLOGICALLY SUPPRESSED OR DEFICIENT SUBJECTS. van Bekkum, D. W. (Organization for Health Research TNO, Rijswijk, Netherlands). pp 305-15 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

Models using mice for providing reasonable approximations to various clinical situations are described. The mice used are newborn, adult, and lethally x-irradiated F_1 hybrids treated with parental lymphoid cells. A table is presented to show numbers of spleen cells, lymph node cells, thymus cells, leukocytes, marrow cells, and thoracic duct cells required to initiate graft versus host reactions in three experimental models. Immune reactions in man following infusion of peripheral blood and leukocyte concentrates are discussed. Immune reactions in man following administration of the following are discussed: allogeneic bone marrow cell suspensions, foetal liver cells, thymus tissue, and organ transplants. In order to prevent unintentional graft versus host reactions it is emphasized that a prospective recipient should be evaluated with regard to the possibility of a decreased immune reactivity and the existence of a decreased population of lymphatic tissues. (H.L.W.)

44781 IMMUNOLOGICAL DETECTION OF THYMIDINE PHOTOPRODUCT FORMATION IN VIVO. Natali, P. G.; Tan, E. M. (Scripps Clinic and Research Foundation, La Jolla, Calif.). Radiat. Res.; 46: No. 3, 506-18(Jun 1971).

Rabbits immunized with uv-irradiated DNA which was complexed to methylated bovine serum albumin as carrier responded by making high titers of antibodies. These were mainly 7S antibodies and reacted only with uv-irradiated DNA, showing no cross reactions with unirradiated native or heat-denatured single-stranded DNA. The reactions were demonstrated in immunofluorescence by showing that rabbit antisera reacted with nuclei of uv-irradiated tissue sections but not with unirradiated tissue nuclei. In complement fixation, antisera reacted only with irradiated purified DNA. Specific antigenic determinants on uv-irradiated DNA were determined by inhibition of immunofluorescence and complement fixation using irradiated thymine and cytosine and the respective nucleosides and nucleotides as inhibitors. Cytosine photoproducts were not inhibitory but thymine photoproducts were partially inhibitory. Irradiated polycytidylic acid was also not inhibitory but irradiated polydeoxythymidylic acid gave complete inhibition. These results demonstrated that antigenic determinants of uv-irradiated DNA were thymine associated photoproducts. Rabbit antisera were used in the immunofluorescent technique to demonstrate DNA photoproducts in tissue nuclei of mice whole-body irradiated with uv. This reaction was completely abolished by prior absorption of antisera with irradiated polydeoxythymidylic acid. Immunologically specific antisera thus provided useful reagents for detection of altered products in photobiological studies. (auth)

44782 PATHOGENESIS OF EXPERIMENTAL ALLERGIC ORCHITIS. I. TRANSFER WITH IMMUNE LYMPH NODE CELLS. Tung, Kenneth S. K.; Unanue, Emil R.; Dixon, Frank J. (Scripps Clinic and Research Foundation, La Jolla, Calif.). Contract AT(04-3)-410. J. Immunol.; 106: No. 6, 1453-62 (Jun 1971).

Experimental allergic orchitis was passively transferred among histocompatible guinea pigs by lymph node cells from animals immunized with sperm in complete Freunds adjuvant. Local transfer of cells into the interstitium of the testes caused severe changes in allergic orchitis within four to eight days. Recipients of immune lymphoid cells were preirradiated in an attempt to kill rapidly dividing cells in the host. Since the dose of irradiation required to affect proliferative capacity of marrow cells was not known, dose effects were compared. At 490 R, no difference was noticed between the testicular lesions of the two groups of recipients. A dose of 640 R of x rays caused marked differences. Results indicated that the monocytic infiltrates in the recipient testes were derived from radiosensitive cells in the host. (H.B.G.)

Ecology

Refer also to abstracts 44473, 46180, 46278, and 46283.

44783 FIRST OBSERVATIONS ON ^{137}Cs CONTAMINATION IN THE ANNELID POLYCHETA ARENICOLA MARINA (L). Triquet, C. (CEA, Cherbourg, France. Univ., Nantes, France). Compt. Rend. Soc. Biol.; 164: No. 7, 1636-8(1970). (In French).

When Arenicola marina (L) is contaminated with ^{137}Cs, it is interesting to study the role of water in the transfer of the radioelement from the medium to the animal. The first researches on the subject show that for an appreciably constant activity in the water the contamination of Arenicola marina increases rapidly, particularly during the first 24 hours. The slope of the curve then decreases, demonstrating that the animal tends to find an equilibrium with its environment. At this moment the concentration factor of the radioelement in the organism reaches a value of about 4.1. (France)

Genetics and Cytogenetics

Refer also to abstracts 44808, 44825, 44919, and 44980.

44784 MOSAICISM AND LETHAL SECTORING IN G1 CELLS OF SCHIZOSACCHAROMYCES POMBE. Abbondandolo, Angelo; Simi, Silvana (CNR, Pisa, Italy). Mutat. Res.; 12: No. 2, 143-50(Jun 1971).

Cells of Schizosaccharomyces pombe synchronized in G1 were treated with increasing doses of ultraviolet light and scored for mosaic and complete purple mutants. As found previously, in experiments with nitrous acid, the relative frequency of mosaics increased with dose within a survival range of 100–12%. Since the hypothesis had been proposed that this kind of dose response could depend on a reduced incidence of lethal sectoring (l.s.) in G1 cells, the role of l.s. in the production of completes was tested by comparing its incidence in G1 and G2 populations treated with NA. An analysis of uv-induced l.s. was then performed in G1 cells, in order to assign to this mechanism a defined fraction of the completes induced at each uv dose. It appeared that l.s. is relevant for the production of completes only at high levels of lethality and that a second mechanism, possibly repair, is active at high survival. (auth)

44785 INDUCTION OF DIRECTIONAL CHROMOSOME ELIMINATION IN SOMATIC CELL HYBRIDS. Pontecorvo, G. (Imperial Cancer Research Fund, London). Nature (London); 230: 367-9(9 Apr 1971).

The chromosomes of one or other of the parents of a hybrid cell are usually gradually lost over successive generations. X-irradiation, γ-irradiation or BUDR (bromodeoxyuridine) labelling of one parent before fusion can be used to predetermine which of the two sets of chromosomes will be preferentially lost. (auth) (UK)

44786 DOSE CURVES OF THE APPEARANCE OF CHROMOSOME REARRANGEMENTS AND MODIFIERS OF CELL METABOLISM. Mitrofanov, Yu. A.; Otradnova, V. V. (Inst. of General Genetics, Moscow. Moscow Veterinary Academy). Radiobiologiya; 11: No. 1, 53-6(Jan-Feb 1971). (In Russian).

The dose curves of x irradiation for rearrangements of the chromosome type in Crepis capillaris were studied in the normal state and under the action of inhibitors of cell metabolism. In the irradiation of C. capillaris cells in the G_1 phase, the overwhelming majority of rearrangements were rearrangements of two-break origin (asymmetrical, symmetrical chromosome translocations, rings, etc.). One-break rearrangements (terminal chromosome deletions at all doses, especially at low doses) arose in limited numbers. The dependence of the number of all types of rearrangements on the dose is not linear, and in most of the curves is represented by an exponential function with an exponent greater than one. The influence of deoxyadenosine and chloromycetin does not change the shape of the dose curves of x irradiation. (tr-auth)

44787 APPEARANCE OF CHROMATID REARRANGEMENTS UNDER THE INFLUENCE OF RADIATION ON THE G_1 PHASE. Dubinin, N. P.; Nemtseva, L. S.; Khalikov, P. Kh. (Inst. of General Genetics, Moscow). Radiobiologiya; 11: No. 1, 57-63 (Jan-Feb 1971). (In Russian).

The irradiation of seeds with an artificially reduced moisture content with large doses of ^{137}Cs γ rays in the presynthetic phase G_1 of a naturally synchronized population of cells of embryonic meristem of Crepis capillaris seeds induced the formation of chromatid rearrangements. Evidently under these conditions, radiation induces primary damages to the chromosomes of two quali-

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tatively different types: the usual short-lived potential damages, realized in the G_1 phase in chromosome rearrangement, and long-lived potential damages, which last up to the S phase and are fixed in chromatid rearrangements. (tr-auth)

44788 MODIFYING ACTION OF CAFFEINE IN THE INDUCTION OF CYTOGENETIC DAMAGES BY GAMMA RAYS IN CELLS OF A TRANSPLANTABLE CHINESE HAMSTER CULTURE. Shalumashvili, M. A.; Tarasov, V. A.; Myasova, Z. N. (Inst. of General Genetics, Moscow). Radiobiologiya; 11: No. 1, 64-8 (Jan-Feb 1971). (In Russian).

A sensitizing action of caffeine on the yield of chromosome aberrations induced by γ rays in the cells of a transplantable Chinese hamster culture in the G_2 phase was demonstrated. Culturing γ-irradiated cells in a medium with caffeine in the postradiation period led to an increase in the yield of deletions and a decrease in the yield of exchange translocations. The presence of caffeine in the medium only at the moment of irradiation does not influence the yield of chromosome aberrations. (tr-auth)

44789 ESR-STUDIES OF THE MECHANISM OF RADIOSENSITIZATION. ACTION OF N-ETHYLMALEIMIDE ON IRRADIATED SULFHYDRYL COMPOUNDS, IRRADIATED DNA, AND IRRADIATED NUCLEOTIDES. Farcasiu, Malvina; Istratoiu, Rodica; Milvy, Paul (City Coll., New York). Radiat. Res.; 46: No. 3, 415-27(Jun 1971).

ESR spectroscopy studies were conducted of the structure and quantity of the free radicals formed during the x irradiation of the following binary systems: N-ethylmaleimide (or N-methylmaleimide)–cysteamine (or cysteine), N-ethylmaleimide–DNA, N-ethylmaleimide–dGMP, N-ethylmaleimide–TMP, N-ethylmaleimide–dCMP, and N-ethylmaleimide–dAMP. The structures of the free radicals formed in the irradiated maleimides alone were also determined. The presence of N-ethylmaleimide during irradiation enhanced the quantity of free radicals in DNA, dGMP, dAMP, and TMP, but no enhancement of the yield in irradiated dCMP was observed. The results were compared with those obtained with pure DNA and its nucleotides irradiated under the same experimental conditions. A mechanism is proposed for the radiosensitization by N-ethylmaleimide which suggests that N-ethylmaleimide hinders radical transfer from the sugar to the base during irradiation. The results were in accordance with two different modes of sensitization by biological organisms: a direct one which involves DNA and an indirect one which involves the binding of SH groups of natural and added radioprotectors. (auth)

44790 NATIVITY OF THE MACROMOLECULE OF ISOLOGOUS DNA AS A CONDITION FOR ITS REPARATIVE EFFECT ON RADIATION DAMAGE. Slotova, Jana; Karpfel, Z.; Kubickova, Dagmar (Inst. of Biophysics, Brno). Biol. Plant. (Prague); 13: No. 2, 100-9(1971).

The effects of isologous DNA on the course of postirradiation repair of meristematic cells of Vicia faba primary roots were studied in detail. A considerable interest was devoted to determinations of fundamental qualitative and quantitative conditions of the above effect of isologous DNA. Main criteria of the effect were both mitotic activity of irradiated cellular population and dynamics of chromosome aberrations induced by radiation. One set of experiments compared the course of reparation as occurred in regard to applied dose of ionizing radiation in native isologous DNA, DNA denaturated by heat and degraded by DNAase; postirradiation reparation of induced damages was favorably affected by native isologous DNA only. Another set of results evaluated the dependence of positive reparative effect of native isologous DNA on the length of the molecule demonstrating that in the process of repair the presence of a complete DNA macromolecule was not essential. In the last experimental group, observations on the dependence of the rate of native isologous DNA effect on concentration of applied solution of the macromolecule were emphasized. (auth)

44791 PIGMENTED MUTANTS OF NADSONIELLA NIGRA AND EFFECTIVENESS OF RADIOMUTAGENS. Lyakh, S. P.; Ruban, E. L. (Inst. of Microbiology, Moscow). Mikrobiologiya; 38: No. 4, 663-6(Jul-Aug 1969). (In Russian).

Several types of stable pigmented mutants of the antarctic black yeast Nadsoniella nigra, induced by x irradiation (200 to 250 krad), are described: those with a weak pigmentogenesis, with an extracellular melanin accumulation, and mutants with a lost ability for melanin synthesis under standard growth conditions. UV monochromatic radiation with a wavelength of 2537 Å almost did not exhibit mutagenic action towards pigmented mutants, while high doses of x irradiation induced these forms in Nadsionella nigra with a high frequency. (Inst. of Microbiology, Moscow)

44792 GENETIC EVIDENCE FOR THE DETACHMENT OF LAMBDA PROPHAGE FROM THE CHROMOSOME OF LYSOGENIC DONOR BACTERIA STRAIN INDUCED BY UV-IRRADIATION. Bylokrysenko, S. S. (Pirogov Second Medical Inst., Moscow). Genetika; 7: No. 5, 123-9(May 1971). (In Russian).

The transmission of the λ prophage and some genetic bacterial markers (Gal-proximal and trp-distal to the phage) by Hfr K1 (λ) strain of Escherichia coli after uv-irradiation was studied. The analysis of the recombinants showed that the population of Hfr lysogenic donor cells after uv induction contains three groups of cells differing in their behavior in mating: initial lysogenic donor cells; cells that retained chromosome breaks after the excision of the lambda prophage; and cells that restored the continuity of the chromosome after excision of the prophage. Most of the Hfr lysogenic cells retained the chromosome break after phage detachment. (auth)

44793 UV-INDUCED MUTAGENESIS IN ESCHERICHIA COLI WP_2 UNDER THE CONDITIONS OF DOSE FRACTIONATION. Likhoded, L. Ya.; Skavronskaya, A. G. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 7: No. 5, 138-41(May 1971). (In Russian).

The frequency of uv-induced mutations in the triptophane locus of Escherichia coli, strain WP_2, under continuous and fractionated irradiation was studied. It was found that the frequency of mutations under a fractionated dose of uv-light was considerably lower than that induced by the same dose under continuous irradiation. A similar mutagenic effect was observed under fractionated and continuous irradiation in case of equal percent inactivation of bacteria. The conditions of the experiment prevented the possibility of the beginning of the bacterial DNA synthesis during the irradiation. It was found that the excision repair did not produce the mistakes resulting in the formation of uv-induced prototrophs. (auth)

Health Physics and Safety

Refer also to abstract 45840.

44794 INVESTIGATIONS ON THE PROPERTIES OF RADON DAUGHTER PRODUCTS USING CELLULOSE NITRATE AS AN ALPHA DETECTOR. McLaughlin, J. P. (University Coll., Dublin). pp VI.56-60 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Studies are being made of the attachment of radon daughter products to condensation nuclei. The mobility spectrum of the alpha emitting aerosols so formed is analyzed in a mobility spectrograph in which the plastic cellulose nitrate is used as an alpha detector. In controlled experiments, by varying the radon loading of the air, it is possible to obtain values of the attachment coefficients involved. (auth) (France)

Radioactive Contamination and Decontamination

Refer also to abstracts 44783 and 44949.

44795 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 4, 199-208(Apr 1971).

Milk sampling networks are an effective mechanism for obtaining information on current environmental radionuclide concentrations and long-term trends. The Pasteurized Milk Network consists of 61 sampling stations in the U. S., one in Puerto Rico, and one in the Canal Zone. Additional networks include the Pan American Milk Sampling Program with five stations and the Canadian Milk Network with 16 stations. The data from these stations on concentrations of radionuclides in milk for the 12 month period January 1970 through December 1970 are given and discussed. Experiments were conducted to determine the accuracy of these data and agreement of measurements among laboratories. In general, considerable improvement is needed, especially in the accuracy of measurements. Efforts are also being made to estimate the dietary intake of selected radionuclides on a continuing basis in order to provide a basis for evaluating the significance of radioactivity in foods and diet. (E.E.H.)

44796 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 12: No. 4, 209-10(Apr 1971).

Extensive water quality and analysis programs are being conducted for surface, ground, and treated water. Most of these programs include determination of gross α and gross β radioactivity and specific radionuclides. The Public Health Service

drinking water standards set the limits for approval of a drinking water supply containing ^{226}Ra and ^{90}Sr at 3 pCi/l and 10 pCi/l, respectively. In the absence of ^{90}Sr and α particle emitters, the gross β activity limit is 1000 pCi/l except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposure greater than the limits indicated by the radiation protection guides. Data are given on the ^{90}Sr concentrations in New York City tap water during 1955 through June 1970. (E.E.H.)

44797 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 4, 211-16(Apr 1971).

Data from the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization on gross β activity in surface air and precipitation are given for December 1970. The locations of the sampling stations and time profiles of gross β radioactivity in air for eight Radiation Alert Network stations are described. The 80th Meridian Program is conducted to determine the concentrations of radionuclides in surface air in both hemispheres as a function of latitude and season and to interpret these data in terms of the dominant meteorological and physical processes that are operative. The basic network consists of a line of sites approximately along the 80th meridian extending from about 76°N to 90°S latitude. The contents of ^{55}Fe, ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{141}Ce, ^{95}Zr, ^{238}Pu, and ^{239}Pu in surface air during January through December 1968 are given. (E.E.H.)

44798 ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS. II. Radiol. Health Data Rep.; 12: No. 4, 228-33(Apr 1971).

Data from the environmental monitoring network on and around the National Reactor Testing Station in eastern Idaho on concentrations of radioactivity are collected routinely from all sources, such as fallout and natural radioactivity. The results of analyses of water for α, β, and tritium, of air for α, β, tritium, and ^{131}I, of milk for ^{131}I and ^{90}Sr, and wheat for ^{90}Sr for July through Dec. 1969 and for the year 1969 are presented. Data from the environmental monitoring program around the Portsmouth Area Gaseous Diffusion Plant on gross α and β radioactivity in air and water for Jan. through June 1970 are also given. (E.E.H.)

44799 ACCIDENTAL RELEASE OF ^{131}I AT LA HAGUE UP2 PLANT. Scheidhauer, J.; Cassabois, G.; Gandon, R. (CEA, Cherbourg, France). Radioprotection; 6: No. 1, 23-44(1971). (In French).

On October 2nd, 1968 an accidental discharge of ^{131}I occurred at the UP2 plant of the La Hague Center. The activity released during about 10 hours did not exceed 5 curies dispersed in about 8 million cubic meters of air. Outside checks, undertaken immediately, failed to show any radiological aftereffects on the milk production in the neighborhood. However, a small herd of milk cows, out to pasture on very slightly contaminated fields, was identified. The production from this herd was followed up and the activities measured in the milk were related to those detected on samples of grass. The results obtained on the grass could not be associated satisfactorily with the activities discharged, the deposition values being lower by a factor 100 than the results predicted by calculation. No atmospheric check was made in the region of the contaminated pastures. (France)

44800 EXPERIMENTAL CONTAMINATIONS WITH AMERICIUM IN SOLUTION AND THEIR TREATMENT. Nenot, J. C.; Morin, M.; Lafuma, J. (CEA, Fontenay-aux-Roses, France). Health Phys.; 20: No. 4, 383-91(Apr 1971). (In French).

Contamination of the body by americium was studied from several points of view: solubility of the salt used in the body, i.e., nitrate and sulfate, mode of contamination i.e., by intravenous or intramuscular injection or inhalation, elimination after treatment with DTPA, given either intramuscularly or by aerosol. The two salts have the same distribution of the absorbed fraction in bone, liver, kidneys and other organs, but the migration speed of the sulfate from the muscle or lung is greater. Even when administered 24 hr after contamination and then repeated once a week, DTPA is very effective in increasing the elimination both from the body and from the site of contamination. After 3 months of treatment with DTPA, muscle and lung contamination was decreased by a factor of 3.3 or 7.3, respectively, and the skeletal contamination decreased by a factor of 4 or 8. In any case of contamination the best mode of administration of DTPA is by injection. For lung contamination, administration by aerosol gives good results, but is less effective in decontaminating the bone. (auth)(UK)

Dosimetry and Monitoring

Refer also to abstracts 44479, 44592, 44638, 44639, 44641, 44646, 44694, 44698, 44704, 44754, 44874–44879, 44888, 44893, 44896, 44899, 44900, and 44948.

44801 (NYO–3086-10(Vol.2)) RADIOACTIVITY STUDIES. Progress Report. Eisenbud, Merril; Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine). 1 Sep 1970. Contract AT(30-1)-3086. 73p. Dep. NTIS.

For abstracts of individual sections see: 44453, 44585, and 44802.

44802 (NYO–3086-10(Vol.2), pp IV.1-18) IN VIVO MEASUREMENT OF CHRONIC ^{241}Am BURDENS IN MAN. Wrenn, M. E.; Rosen, J. L.; Cohen, N. (New York Univ., N. Y. Inst. of Environmental Medicine).

From Radioactivity studies.

Early in 1970 an incident involving the chronic exposure of six persons to ^{241}Am was discovered. Evidence indicates that the initial exposure occurred in the latter half of 1963 continuing through the beginning of 1970. The source of the material was a planchett coated with ^{241}Am, the chemical composition of which was unknown. The mode of exposure was believed to be primarily through inhalation. The total activity of the ^{241}Am probably exceeded 10 millicuries. Methods used for estimating the levels of activity in the six persons are described. In conjunction with the estimation of the body burdens, some information was gathered on the tissue distribution of activity for two of the subjects. All estimates were made using in vivo counting techniques. (C.H.)

44803 GONADAL EXPOSURE IN RADIATION TREATMENT. PART 2. MEASUREMENT OF GONAD DOSE IN RADIATION TREATMENT OF BENIGN DISEASES. Iba, Shozo; Kakehi, Hirotake; Arimizu, Noboru (Chiba Univ., Japan). Nippon Hoshasen Gijutsu Gakkai Zasshi; 26: 82-9(Jun 1970). (In Japanese).

Radiation treatment was given to 719 patients with a variety of benign diseases, equivalent to 4.1% of all out-patients, visiting the Department of Radiology, Chiba University Hospital between August, 1954, and December, 1968. The localizations of the radiation treatment were classified into the following four groups: head and neck; chest and upper abdomen; lower abdomen and thigh; and extremities. The group with head and neck exposure was 74% of all treated cases. The annual number of cases of benign diseases have been decreasing in recent years. The age distribution of the patients indicated the largest number was 16 to 25 years old. Gonadal exposure was measured on 74 cases using the pocket chamber placed either on the genitals or at the vaginal fornix. The differences in conditions of the treatment resulted in a variety of measured doses. The average dose received by the gonads was 10 mR with conventional x-rays and 28 mR with the telecobalt γ rays. The group with lower abdomen and upper thigh exposure showed much higher gonadal exposures than the other groups, reaching up to 65 mR per 100 R dose of conventional x rays, though lead rubber sheets were used to cover the area outside the irradiated field. The average accumulated dose to the gonads during the full course of treatment ranged from 123 to 176 mR with the conventional x rays and from 632 to 775 mR with telecobalt γ rays. (auth)

44804 RADIATION PHYSICS. Boag, J. W. (Inst. of Cancer Research, Belmont, Eng.). pp 31-43 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC–10/123.

Accurate radiation dosimetry permits biological experiments done at different times or places to be reproduced and compared and also provides basic physical data to test any theory of the mechanism of radiation action. An accurate physical method of measurement of the radiation delivered and a detailed knowledge of pathways by which energy is transferred from the radiation source to the biological material are needed for radiation dosimetry. Those features of the interactions of radiation with matter that are relevant to an understanding of the biological effects of radiation are discussed in a simplified form. The terms commonly used in radiation dosimetry are defined; the relationship between absorbed dose, linear energy transfer, and biological effects are discussed, and the direct and indirect effects of radiation on biological materials are reviewed. (C.H.)

44805 BIOPHYSICAL BASIS FOR RADIATION HAEMATOLOGY. Spiers, F. W. (Univ. of Leeds, Eng.). pp 45-69 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC–10/123.

Physical characteristics of ionizing radiations are discussed in relation to biological effects; characteristics of charged particles, x rays, gamma rays, neutrons, particle tracks, and linear energy transfer are emphasized. Units of radiation dose are discussed with regard to absorbed dose, radiation exposure, LET, and relative biological effectiveness. The location of relevant

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hematological tissues is discussed and a physical description of trabecular bone is given with regard to distribution of active marrow, bone mensuration, and path length distributions. Methods of determining mean dose to active marrow are described with emphasis on single cavity calculations, mean marrow dose, multiple cavity calculations, and results for x rays and beta particles. Alpha particle and neutron irradiation are reviewed with regard to volume and surface distributed radioisotopes, alpha particle dose from volume-distributed radioisotopes, alpha particle dose from surface-distributed radioisotopes, ^{239}Pu dosimetry in rabbit bone and bone marrow, and bone marrow dose from neutron irradiation. (H.L.W.)

44806 HAEMATOLOGICAL PARAMETERS AFTER ACUTE RADIATION INJURY. Wald, N. (Univ. of Pittsburgh). pp 253-64 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The purpose of this chapter is to explore the utilization of blood and marrow cell changes as a diagnostic and prognostic tool to evaluate the severity of injury resulting from radiation exposure in man. The term "biological dosimeter" has been used loosely to describe this application of haematologic data, but it is an unfortunate term because of its ambiguity. The two most widely used meanings of this term are: a quantitative biological response system whose dose-response pattern can be characterized with sufficient accuracy to allow a valid assessment of the physical dose on the basis of the haematologic change measured; and a response system in which direct biological measurements are performed to assess the clinical outlook in cases of suspected radiation injury. Dose-response relationships are discussed with regard to effects of dose on counts of lymphocytes, neutrophils, platelets, and reticulocytes and bone marrow mitotic index. Response-injury relationships are discussed with regard to peripheral blood changes, bone marrow changes, and hematological tests with clinical applicability. (H.L.W.)

44807 HAEMATOLOGICAL BASIS FOR THE EVALUATION OF RADIATION EXPOSURE. LOW-LEVEL, LONG-TERM EXPOSURES, AND LATE EFFECTS. Ingram, M. (Univ. of Rochester, N. Y.). pp 265-75 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The validity of the concept that the haematological changes observed after exposure to large doses of ionizing radiation reflect primarily a decrease in proliferation of blood cell precursors has been documented by extensive research representing many mammalian species and is now widely accepted, as indicated in other chapters in this volume. Ionizing radiation has, in fact, become a standard experimental agent in haematological research concerned with the kinetics of cellular proliferation in haematopoietic tissues. Much less is known about the mechanism of late and latent effects of exposure and about the effects of small radiation doses applied frequently over long periods of time—the type of exposure most likely to occur in radiation work and that with which this chapter is primarily concerned. In such exposures individual doses are far too small to be lethal to most cells and repair processes proceed during the periods between exposures and even during exposure at low dose rates. Haematological changes related to low-level exposures tend to be subtle and often delayed in onset. Problems encountered in identifying and measuring them are those encountered in evaluating the effects of lowest effective doses of any agent; they arise from uncertainty implicit in the assumption that the most sensitive indicators have, in fact, been selected and that the effects have been sought with sufficient knowledge, skill, diligence and insight. Negative results in such studies may mean simply that effects remain undiscovered, not that they are absent. A review of major types of hematological change includes discussions of changes in numbers of circulating cells and production of aberrant cells such as binucleate lymphocytes, lymphocytes with nuclear fragments and neutral bodies, immature monocytes, giant hypersegmented granulocytes, nucleated red cells, and giant platelets. A review of exposure variables to be considered includes discussions of dose/time units in analysis of data and partial body exposure. The nature of late and latent effects is discussed with regard to indirect or secondary effects and possible effects of sublethal injury on cell survival. Methods of unmasking latent effects are discussed including the use of newer automatic techniques by means of the Coulter Counter, model B, and the Particle Size Plotter, model H. (H.L.W.)

44808 USE OF CHROMOSOME ANALYSIS IN THE DIAGNOSIS OF RADIATION INJURY. Bender, M. A. (Vanderbilt Univ., Nashville). pp 277-85 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The production of chromosomal aberrations by ionizing radiation offers a useful means of diagnosing radiation exposure. In general, in the absence of complicating factors an increase in chromosomal aberration level can be taken as an indication of radiation exposure, smaller increases indicating small exposures and larger increases indicating larger exposures. Under some circumstances, in fact, chromosomal aberration frequencies can be used as a "biological dosimeter" to provide quantitative estimates of the magnitude of exposures. The dose-effect kinetics for various aberration types and for various radiations is well known and reasonably accurate expressions relating aberration yield to radiation dose can be written. Thus, when the yields have been measured the expressions may be solved for the unknown dose. Preparative techniques, scoring methods and even nomenclature for aberration types vary from laboratory to laboratory. The purpose of this account is rather to provide basic information that will allow non-cytogeneticists to exploit cytogenetic techniques for radiation diagnosis. The following topics are discussed: cytogenetic analysis; spontaneous aberration rates; acute radiation exposures; chronic, fractionated, and old exposures. (auth)

44809 BIOCHEMICAL INDICATORS OF RADIATION INJURY. Szabo, L. D.; Antoni, F. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). pp 287-96 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Various techniques that utilize biomedical parameters are being employed to determine the degree of radiation damage and to relate it to the absorbed dose. The majority of these are based on biological responses to ionizing radiation, the degree of response being considered as proportional to the radiation dose, i.e., as dose dependent. Accordingly, these biological radiation responses have been termed "biological dosimeters" or, more appropriately, "biological indicators" of radiation damage. The ideal biological indicator of radiation damage would be one that is specific, sufficiently sensitive, suitable for detection of small radiation doses and would permit the determination of the degree of damage within the shortest possible time after irradiation. The ideal method should be simple and applicable to screening large numbers of people, if necessary. It is an established fact that ionizing radiation alters the metabolism of cells, tissues and the whole organism. It is, therefore, understandable that attention has been focussed recently on the metabolic products produced in and excreted from the organism after irradiation. The results of metabolic studies in irradiated organisms and the possibilities for their use in practice are discussed below. The observable effects of irradiation on the whole organism are the result of damage to essential macromolecules at the sub-cellular level and to the permeability of the cells. Irradiation induces considerable changes in the biopolymers of the cell (nucleic acids and proteins) and in the metabolism of non-biopolymer types of compounds that have biological activity (vitamins, steroid hormones, etc.). Owing to the increased cell permeability, the lower and higher molecular weight compounds may leave the cell; among these, and most important, are the amino acids (the essential components of proteins), nucleotides (the building blocks of nucleic acids) and hormones (regulators of homeostasis in the body). Enzymes, their co-factors and substrates are among the substances that leak through the cell membrane and as a consequence the relationship between enzymes and enzyme systems will be altered. Disturbances in the energy metabolism of the cell and in DNA synthesis will affect cell proliferation and may cause extensive cell death. The especially radiosensitive haemopoietic, lymphatic and intestinal epithelium cells are the first casualties. The cell-degradation products enter the blood circulation and are excreted in the urine. The nature and significance of these metabolic products originating from the breakdown of biopolymers after ionizing radiation are discussed. (auth)

44810 DOSE ASSESSMENT OF IONIZING RADIATION EXPOSURE TO THE POPULATION. Terpilak, Michael S.; Weaver, Charles L.; Wieder, Samuel (Environmental Protection Agency, Rockville, Md.). Radiol. Health Data Rep.; 12: No. 4, 171-88(Apr 1971).

The population dose from natural background, residual weapons test fallout, nuclear power operations, and medical and dental uses of ionizing radiation is reviewed. Reported and projected population exposures from these sources indicate that, for the near future, the predominant exposure to the public will be attributable to natural background and to medical x rays. A continual evaluation to

assess priorities, based on magnitude and type of exposure, and investigations into the biological effects of radiation constitute important features of public health responsibility. A declining trend is in prospect for exposure to weapons test fallout in the absence of major atmospheric nuclear explosions. Exposure resulting from all procedures related to nuclear power operations and from diagnostic medical radiation (x rays and internally administered radionuclides) is projected to become of increasing consequence. These warrant increased attention in planning for surveillance. Surveillance associated with peaceful uses of nuclear explosions (Plowshare Program), and with tests of nuclear engines for propulsion, requires individual programming. (auth)

44811 PUBLIC HEALTH ASPECTS OF ^{129}I FROM THE NUCLEAR POWER INDUSTRY. Russell, John L. (Environmental Protection Agency, Rockville, Md.); Hahn, Paul B. Radiol. Health Data Rep.; 12: No. 4 189-94(Apr 1971).

The production of ^{129}I in nuclear power reactors and its subsequent environmental releases during fuel reprocessing represents a potential long-term public health problem. Because of its extremely long half-life, any discharged ^{129}I is essentially a permanent contaminant in the biosphere, where it will eventually be found as a fraction of total iodine within a locality and possibly worldwide. This potential problem, its possible geographical scope, and the projected impact on population exposure are discussed along with data from measurements at nuclear power reactors and a fuel reprocessing plant. A concentration of 0.86% ^{129}I in total iodine produces the dose limit recommended by the Federal Radiation Council (FRC) for a suitable sample of an exposed population. The quantity of ^{129}I discharged from operating power reactors was estimated from measurements of ^{131}I discharges by calculating an ^{129}I to ^{131}I buildup ratio. This analysis showed that the ^{129}I discharge from operating power reactors was negligible. Measurements at a fuel reprocessing plant indicated that approximately 10 percent of the total ^{129}I inventory in spent fuel was discharged from the stack during the batch dissolution process. The liquid discharge concentrations were about 2% of the total ^{129}I inventory. ^{129}I levels in deer thyroids taken in the reprocessing plant locality were about 40% of levels of FRC guidance for human thyroids. (auth)

44812 STATISTICAL LIMITS OF ACCURACY AND PRECISION OF GROSS ALPHA AND BETA RADIOACTIVITY MEASUREMENTS IN WATER. Baratta, Edmond J.; Knowles, Forrest E. Jr. (Northeastern Radiological Health Lab., Winchester, Mass.). Radiol. Health Data Rep.; 12: No. 4, 195-8(Apr 1971).

The results of a technical experiment designed to determine the effectiveness of measurements for gross α and β radioactivity in water are presented. Since this analysis is normally used as a screening technique, it is essential that the limits of precision and accuracy of the method be known. Gross measurements are still being used in preoperational reactor surveys as an indication of the background levels and to monitor radioactivity when the reactor becomes operational. In addition, the Public Health Service standard for drinking water has, in lieu of a determination of radium-226 and strontium-90, limits for gross alpha and beta radioactivity, respectively. The precision and accuracy of a standard method for analysis of gross alpha and beta radioactivity in water were determined through the cooperation of private and government laboratories. It was found that gross alpha radioactivity could be determined with an overall precision of 12 percent, while the gross beta radioactivity could be determined with a precision of 7 percent. The accuracy of the gross alpha activity measurements was within 10 percent, and for the gross beta activity measurements, 1 percent. (auth)

44813 MEASURING OF THE STANDARD IONIC DOSE IN COMPACT AND LIQUID MEDIA DURING X-RAY AND GAMMA IRRADIATION BY ENERGIES BETWEEN 50 keV AND 3 MeV. VII. MEASUREMENT RESULTS OF STANDARD IONIC DOSES WITH CAVITY IONIZATION CHAMBERS IN SOLID AND LIQUID MEDIA. Will, Wolfram; Rakow, Adalbert (Medizinisch-Biologische Forschungszentrum, Berlin). Strahlentherapie; 141: No. 4, 421-4(Apr 1971). (In German).

The influence of various items on the sensitivity of ionization chambers in air and in non-gaseous media is reviewed, and some conclusions are drawn. Whereas an ionization chamber has the same sensitivity and response for different energies within a phantom as at the calibration in air it is necessary to compensate mutually as the most important items the stem effect in air and the volume effect within the phantom by construction of a chamber with an appropriate diameter. (auth)

44814 DETERMINATION OF ^{232}Th CONTENT IN A FEW OLD THOROTRAST AMPOULES. Malatova, I. (Inst. of Radiation Hygiene, Prague). Strahlentherapie; 141: No. 4, 491-3 (Apr 1971).

During a period of 4 years, 8 thorotrast ampoules from the firm of Heyden were measured by gamma spectrometry and the activity 0.322 ± 2% μCi ^{228}Th was determined. The ratio $^{228}Th/^{226}Ra$ = 0.994 ± 1% guaranteed a product age of 37 ± 14 years. These results afforded the determination of the ^{232}Th content within limits of 0.246 to 0.258 g/ml. In another ampoule produced by the same firm with equal volume and practically identical description, the ^{232}Th content of 0.195 g/ml was found and this is the value currently stated for example in the UNSCEAR Reports. The possibility that the absorbed doses may be underestimated, if the values of 0.20 g/ml are applied as standard, is discussed. (auth)

44815 DESCRIPTION OF RADIATION FIELDS BY MEANS OF SEPARATION OF PRIMARY AND SCATTERED RADIATION. V. CALCULATION OF THE DOSE DISTRIBUTION OF DIVERGENT PHOTON RADIATION FIELDS. Schoknecht, Guenter (Freie Univ., Berlin). Strahlentherapie; 141: No. 4, 409-15 (Apr 1971). (In German).

The method to calculate the scattered dose distribution for extended fields of parallel beams from the scattering distribution of a pencil beam, using a two-dimensional convolution integral, is also applicable in a modified form for radiation fields of not too extensive divergence. This is only possible under the condition that the scattering distribution in a certain depth solely depends upon the distribution of the primary dose in this depth. The applicability of the calculating method was investigated by experimental studies on ^{60}Co radiation fields. The examinations comprise the tissue-air-ratio as well as one- and two-dimensional dose distributions. (auth)

44816 DISTRIBUTION OF TISSUE DOSES IN THE RED BONE MARROW. Rasin, I. M.; Sarapul'tsev, I. A.; Panteleev, L. I. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 2, 221-3(Mar-Apr 1971). (In Russian).

Investigations were made of the statistical distribution of the size of trabeculae and bone marrow cavities. The weighted average and percent distribution of the dose rate created by strontium-90 in the red bone marrow of different organisms were determined. Formulas are given for calculating the dose rate in the red bone marrow. (tr-auth)

44817 STUDIES RELATING TO IN VIVO ACTIVATION ANALYSIS USING A SOURCE OF 14 MeV NEUTRONS. Marshall, T. O.; Knight, A. (Radiological Protection Service, Belmont, Eng.). Nucl. Instrum. Methods; 92: No. 4, 595-9(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

It is shown, in carrying out activation analysis in vivo with a source of moderated 14-MeV neutrons, that the choice of slow-neutron activation detector to measure the resultant distribution of slow-neutron fluence within the subject being analyzed or in a system designed to simulate the subject is relatively unimportant. Similar results are obtained using either indium or sodium activation detectors or a BF_3 tube. Moreover, the presence of body cavities does not appreciably upset the distribution of slow-neutron fluence within the subject. In preparing a standard against which to compare the activity produced in the subject, however, if the concentration of the element in question is appreciably greater than that in the body, then depression of fluence may occur. The results of measurements with nuclear emulsions of the fast-neutron dose equivalents throughout a water-filled model of the chest are reported. (auth)

44818 USE OF 14 MeV NEUTRONS FOR ACTIVATION ANALYSIS OF FIVE ELEMENTS IN MAN-LIKE MODELS. Battye, C. K. (King's Coll. Hospital, London); Knight, V.; Marshall, T. O.; Knight, A.; Godfrey, B. E. Nucl. Instrum. Methods; 92: No. 4, 601-7(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Methods using neutron activation analysis for the determination of the whole-body content of an element in a living subject are now well established. The preliminary experiments described here relate to a method of analysis that allows 5 body elements to be estimated simultaneously. Fast (14-MeV) neutrons, produced by a low-energy accelerator by using the $^3H(d,n)^4He$ reaction, were used to activate a number of man-like models. The γ-ray spectra of activity from the models were then recorded and compared with those from similar activated models each containing only one of the elements of interest. The irradiation was arranged to produce the same effect as that which would have been produced by an arrangement suitable for irradiating humans, i.e. one which produces uniform fluence of slow neutrons throughout the body by moderation of the incident 14-MeV neutrons. A method of analyzing the spectra is described which takes account of the activity

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produced by the many interfering reactions that occur between the fast neutrons and body elements. Results obtained by activation analysis of man-like models are compared with the known contents of the models and shown to be within 18% of the correct values in every case. (auth)

Radiation Protection

Refer also to abstract 44959.

44819 HISTORY OF RADIOINDUCED DAMAGE AND ITS PREVENTION. PART II. Ratkoczy, Nandor (Univ., Budapest). Strahlentherapie; 141: No. 4, 425-38(Apr 1971). (In German).

Biological, germicidal, inflammatory, and depilatory effects of radiation are reviewed. After a description of therapeutic experiments, reports related to increasing local and general damages of radiation are discussed. The biologically damaging effects were believed not to originate from radiation but rather from high voltage current needed for production of radiation. This opinion dominated until the first years of this century. Therefore, many devices to prevent radiation damage are discussed first: lamellas of metal to lead off current like cartoon aluminium foil, and lamellas of lead. Also reviewed are damage of organs, genitals, and genetic material. Protection of patients, protection of doctors, and protection against secondary radiation are discussed chronologically. Devices, materials, and measures to prevent damage of radiation are discussed in detail. (auth)

44820 EXAMINATION OF A VETERINARY PRACTICE FOR RADIATION HAZARDS. O'Riordan, M. C. (Radiological Protection Service, Sutton, Eng.). J. Small Animal Pract.; 11: 515-22(Aug 1970).

The new "Code of Practice for the Protection of Persons exposed to Ionizing Radiations from Veterinary Uses" recommends that a radiation survey of x-ray installations be carried out. Such a survey, consisting of examination of equipment, procedures, and premises is described. (auth)

44821 PREVENTIVE CARE OF MEDICAL WORKERS HANDLING X-RAY EQUIPMENT. Skokanova, K.; Ziegierova, V. (Regional Hygienic Station, Prague). Prakt. Lek.; 50: No. 2, 68-71(20 Jan 1970). (In Czech).

A brief outline is given of measures taken in the preventive care of medical personnel exposed to radiation. In the majority of medical personnel examined between the years 1964 and 1968, exposure did not reach the permissible dose of 5 R/year. The highest doses were ascertained in doctors working at large facilities carrying out specialized examinations and in auxiliary personnel supporting patients, especially children, during examination. (NSA of Czech)

44822 INVESTIGATIONS ON THE PENETRATION OF SUPER-HEAVY HYDROGEN (TRITIUM) THROUGH THE SKIN INTO THE HUMAN BODY DURING HANDLING OF LUMINOUS PAINTS. Billaudelle, H.; Kaltenhaeuser, A. (Battelle-Institute eV, Frankfurt am Main). Arbeitsmed. - Sozialmed. - Arbeitshyg.; 6: No. 2, 38-43(1971). (In German).

A suction box is described that reduces the inhalation of tritium during luminous dial painting. The course of tritium concentration in the air of the box during working time was determined, showing 2 maxima in comparison with 3 higher and more distinct maxima in a room without boxes. The measurement of tritium content in the urine of 3 test persons showed a markable decrease after working in the box, on the average 60% of the value without boxes. This residual activity is attributed to the incorporation of tritium through the skin on the hands. (INIS)

44823 TIME OF CHALLENGE TO THE HEALTH PHYSICIST. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). Health Phys.; 20: No. 5, 491-8(May 1971).

The position of the health physicist in both the industrial and medical applications fields is discussed. In the former, the early much criticized conservative attitude adopted by health physicists to radiation standards has proved beneficial to the nuclear industry but in the latter there is little to be proud of. The proliferation of the duties of health physicists in universities etc. is considered and the lack of these officers and indeed of any radiation protection program in many institutions and civic environments deplored. It is stated that the definition of health physicists has been extended to include the study of the effects of all forms of electromagnetic radiation and all forms of particulates capable of producing ionization. The controversy relative to nuclear reactor siting is considered. (UK)

Safety Procedures

Refer also to abstract 44468.

Medicine

44824 PHARMACOLOGICAL BASES OF NUCLEAR MEDICINE. zum Winkel, K. (Univ., Berlin). Therapiewoche; 21: No. 20, 1599-1600; 1602-4(19 May 1971). (In German).

A survey of radiopharmaceuticals is given. Discussed are chemical, physical, and biological properties of various compounds. The present state of nuclear medicine and promising developments in the future are outlined. (H.B.G.)

Protective Substances

Refer also to abstract 44979.

44825 MECHANISM OF FAR-RED SENSITIZING EFFECT ON X-RAY INDUCED CHROMOSOME ABERRATIONS IN ALLIUM FISTULOSUM SEEDLINGS. Tarasov, V. A. (Inst. of General Genetics, Moscow). Genetika; 7: No. 6, 54-65(Jun 1971). (In Russian).

The work is concerned with the far-red effects on x-irradiated seedlings of Allium fistulosum. The effect of three-hour far-red exposure on chromosome aberration yield at different time following 25, 100, and 200 R of x irradiation was studied. Besides, the effects of different doses of far-red at the dose of 100 R of x irradiation, as well as of the time interval between long-waved and ionizing radiations were studied. The sensitizing effect of far-red is likely to depend on the suppression of post-radiation repair depending in turn on the decreased with time probability of fixation of chromosome potential lesions. (auth)

44826 REPAIR OF RADIATION DAMAGES TO CHROMOSOMES OF BONE MARROW CELLS AFTER THE INTRODUCTION OF HIGH-POLYMER HOMOLOGOUS DNA. Muksinova, K. N.; Rusinova, G. G.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 69-73(Jan-Feb 1971). (In Russian).

It was shown on rats of the Wistar line, γ-irradiated at a dose of 100 R, that high-polymer homologous DNA, introduced after irradiation, lowered the frequency of chromosome aberrations in bone marrow cells. A study of the assimilation of ^{3}H-DNA by hematogenic cells of these animals gave evidence that the repair of chromosome damages probably occurs by an incorporation of exogenous DNA or its fragments into the genome of the recipient cells. In the case of a sharp limitation and slowdown of the incorporation of the introduced DNA (300 R), repair of the damaged chromosomes is not observed. (tr-auth)

44827 PROTECTIVE EFFECTIVENESS OF THE BONE MARROW IN PROLONGED IRRADIATION WITH CONSTANT OR DROPPING DOSE RATE. Khaitov, R. M. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 96-101(Jan-Feb 1971). (In Russian).

Mice of the CBA or CBAT6T6 line were irradiated with the γ rays of ^{137}Cs for 96 hrs at a dose of 1500 R with a constant or dropping (from 326.5 to 0.23 R/hr) dose rates. After the end of irradiation, various numbers of syngenic bone marrow cells were transplanted into recipients. High doses (2×10^7 karyocytes) of bone marrow provided an equal (maximum) protective effect in the case of transplantation into recipients subjected to prolonged irradiation both with a constant and with a dropping rate, but small doses of cells (4×10^4, 4×10^5) provided nonequivalent protection. The decrease in the protective effectiveness of the bone marrow in the case of transplantation of small doses of cells was more pronounced in recipients subjected to prolonged irradiation with a dropping dose rate. (tr-auth)

44828 INFLUENCE OF HIGH-POLYMER HOMOLOGOUS DNA ON THE STATE OF THE NATURAL IMMUNITY IN IRRADIATED ANIMALS. Tkach, L. A.; Muksinova, K. N. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 114-19(Jan-Feb 1971). (In Russian).

Homologous DNA administered to rats 24 hrs after irradiation at a dose of 655 R ($LD_{50/30}$), promoted a smaller decrease in the factors of natural immunity studied—the bactericidal properties of the lysozyme titer of the blood serum, the bactericidal properties of the oral mucosa. In DNA-treated animals, radiation bacteremia and bacterial invasion of the organs were less pronounced. (tr-auth)

44829 BIOCHEMICAL-PHARMACOLOGICAL ANALYSIS AND POTENTIATION OF THE RADIOPROTECTIVE EFFECTS OF AMINOTHIOLS IN THE INTESTINAL FORM OF ACUTE RADIATION SICKNESS. Kulinskii, V. I. (Inst. for the Advanced Training of Physicians, Kharkov). Radiobiologiya; 11: No. 1, 86-91(Jan-Feb 1971). (In Russian).

The influence of blockage of the catecholamine depots and the adrenoreceptors on the protective effect of aminothiols was studied

on 1120 mice x-irradiated at a dose of 1320 rad ($LD_{100/5.5}$). Preliminary administration of noradrenalin [against a background of dibenamine, cocaine, or anaprylin (propranolol)] substantially increased the prophylactic action of cystamine. In the case of a combination of dibenamine, anaprylin, noradrenalin, and cystamine, 16% of the mice survived. The addition of AET to this combination led to the survival of 46% of the mice. A similar effect was given by combinations with noradrenalin or anaprylin excluded. These results far exceeded the effect of individual classical radioprotectors: cystamine, AET, and mexamine. The importance of biochemical-pharmacological approaches (primarily the study of deposition) in the investigation of the mechanisms of the protective action and the search for ways of increasing the effectiveness of protectors is emphasized. (tr-auth)

44830 INFLUENCE OF NEW CASTLE DISEASE VIRUS ON THE RADIORESISTANCE OF WHITE MICE. Yabrov, A. A.; Sverdlov, A. G. (Ioffe Inst. of Physics and Tech., Leningrad). Radiobiologiya; 11: No. 1, 138-40(Jan-Feb 1971). (In Russian).

Intravenous injection of the virus, possessing interferonogenic activity, one to three days before x irradiation, increased the survival of white mice subjected to the action of radiation. (tr-auth)

44831 TOXICITY AND RADIOPROTECTIVE ACTIVITY OF CERTAIN AMMONIUM AND SULFONIUM COMPOUNDS. Kostyukovskii, Ya. L.; Vladimirov, V. G.; Strel'nikov, Yu. E.; Slavachevskaya, N. M. (Military-Medical Academy, Leningrad). Radiobiologiya; 11: No. 1, 141-4(Jan-Feb 1971). (In Russian).

It was shown that in analogs of cysteamine (and its disulfide), as the degree of substitution at the nitrogen atom is increased, there is an increase in the toxic properties and a decrease in the radioprotective properties. Replacement of the ammonium group by a sulfonium group, while leading to a decrease in the toxicity of the compounds, does not provide a restoration of their radioprotective activity to the level observed for cysteamine. (tr-auth)

44832 PROTECTIVE EFFECT OF AET IN THE IRRADIATION OF PREGNANT FEMALES WITH X RAYS. Stanzhevskaya, T. I. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya; 11: No. 1, 144-7(Jan-Feb 1971). (In Russian).

The radioprotective preparation AET (S-2-aminoethylisothiuronium Br·HBr) was administered in a dose of 200 mg/kg to pregnant female rats on the 4th, 10th, 11th, and 13th days of fetal development, 20 min before a single total irradiation with X rays. The death rate of the embryos and percentage of abnormal fetuses were determined. Preliminary administration of AET reduced the teratogenic action of irradiation in the case of influence at the peak of teratogenic activity from 100 to 34.4%; in the case of administration on the 13th day of pregnancy, the number of developmental anomalies of the limbs was lowered from 75.4 to 32.5%. Preliminary administration of AET negligibly reduced the lethal effects of irradiation from 96.1 to 77.4%. (tr-auth)

44833 PHARMACOLOGY OF THE INDOL AND BENZOFURAN DERIVATIVES. Il'yuchenok, T. Yu.; Frigidova, L. M.; Maksimenko, A. A.; Trofimov, F. A. (Inst. of Medical Radiology, Obninsk, USSR). Farmakol. Toksikol.; 33: No. 5, 576-81(Sep-Oct 1970). (In Russian).

Comparative data on the pharmacological (arterial pressure, β-adrenoreceptors block, diuresis, and toxicity) and radioprotective properties of 5-metoxytryptamine and of its homologue with their oxygen analogues, benzofuran derivatives, differing from the former in the nature of the heterological atom and position of the β-ethylamine chain are given. (auth)

44834 HEMORRHAGIC SYNDROME IN THE IRRADIATION DISEASE. II. EXPERIMENTAL STUDY ON THE RADIOPROTECTIVE EFFECT OF CYSTAMINE AND OF THE TREATMENT WITH HOMOLOGOUS BONE MARROW NUCLEIC ACIDS ON COAGULATION AND FIBRINOLYSIS IN RATS EXPOSED TO LETHAL X-RAY DOSES. Cutcudache, Caliopi; Boldescu, Gabriela; Popa, Rodica; (and others). Fiziol. Norm. Patol. (Bucharest); 16: No. 2, 169-77(Mar-Apr 1970). (In Rumanian).

The radioprotective effects of cystamine and homologous marrow nucleic acids on coagulation and fibrinolysis alterations were determined by biologic tests in rats exposed to lethal x-ray doses (700 R). The results obtained 2, 5, 10, and 15 days after irradiation, showed that cystamine administered orally has in general a favorable effect upon coagulability of the blood. Differential coagulation tests showed that, on the one hand, cystamine protected proaccelerin and stimulated thrombocytic recovery in the irradiated animal and, on the other, did not exercise an inhibitory effect on prothrombin. The decrease of antithrombin III is discussed, as well as the possible mechanism of action of cystamine on blood coagulation in vivo, under conditions of irradiation with lethal doses. Homologous marrow nucleic acids, with the molecular weight and dose administered, did not offer a satisfactory protection, either from the biological or the clinical point of view. (auth)

44835 EFFECT OF SINGLE STRUCTURAL COMPONENTS OF BACTERIAL LIPOPOLYSACCHARIDES ON THE RADIOSENSITIVITY OF THE MOUSE. Langendorff, H.; Langendorff, M.; Weckesser, J.; Steinbach, K. H. (Univ., Freiburg i. B.). Strahlentherapie; 141: No. 4, 457-63(Apr 1971). (In German).

The effects of particular structural components of lipopolysaccharides (LPS) of S. minnesota, E. coli, and Rhps, capsulata on the increase of radioresistance were investigated. It was found that the polysaccharide-fraction of the different LPS in a radiation protection test on the mouse was not effective. Neither the O-specific chains nor the core of S. minnesota reduced the radiosensitivity of the laboratory animals. The polysaccharide-fraction (degraded polysaccharide) of the LPS from E. coli or Rhps. capsulata had no appropriate efficacy. In contrast, the lipid-A of the LPS from the three species of bacteria acted to increase radioresistance as well as the corresponding LPS. The test results proved that the lipid-A is the effective structural component of the LPS used in the radiation protection test in mice. (auth)

44836 INFLUENCE OF CYSTAMINE ON THE CHANGE IN THE NUMBER OF DYSPLASTIC HAIRS AND NUCLEATED CELLS OF THE BONE MARROW IN IRRADIATED MICE AND RATS. Lukashin, B. P. (Military Medical Academy, Leningrad). Radiobiologiya 11: No. 2, 212-16(Mar-Apr 1971). (In Russian).

A comparative study was made of the radioprotective activity of cystamine by determining the number of dysplastic hairs in the phase of growth and nucleated cells in the bone marrow of rodents under conditions of whole-body x irradiation. The method of determining dysplasia of the hairs is a sensitive test for quantitative evaluation both of the radiation effect and the protective action of certain protectors. (tr-auth)

44837 INVESTIGATION OF THE RADIOPROTECTIVE EFFECTS OF INOSITOL IN THE IRRADIATION OF E. COLI B WITH HEAVY IONS. Krasavin, E. A.; Ryzhov, N. I.; Shashkov, V. S. Radiobiologiya; 11: No. 2, 249-52(Mar-Apr 1971). (In Russian).

The modifying influence of inositol on the survival of E. coli B under the influence of heavy ions was demonstrated. A distinct radioprotective effect of inositol was detected in the case of irradiation of the cells with boron, carbon, and neon ions. The maximum value of the DRF was equal to 1.7. (tr-auth)

44838 COMPARATIVE STUDY OF THE RADIOPROTECTIVE ACTIVITY OF CYSTAMINE IN THE CASE OF LOCAL AND TOTAL IRRADIATION OF MICE AND RATS. Lukashin, B. P.; Dzharak'yan, T. K. (Military Medical Academy, Leningrad). Radiobiologiya; 11: No. 2, 285-8(Mar-Apr 1971). (In Russian).

A comparative study was made of the radioprotective action of cystamine under conditions of local and total x irradiation by determination of the number of dysplastic hairs in the stage of growth and of nucleated cells in the bone marrow of rodents. The dose reduction factor of cystamine according to both the indexes used proved to be the same, both for local and for total irradiation. (tr-auth)

44839 EFFECTIVENESS OF RADIOPROTECTORS IN THE CASE OF REPEATED IRRADIATION. Sverdlov, A. G.; Bogatyrev, A. V.; Kavukchyan, T. V. (Ioffe Inst. of Physics and Tech., Leningrad). Radiobiologiya; 11: No. 2, 288-92(Mar-Apr 1971). (In Russian).

A pronounced protective effect was obtained for mexamine, cystaphos, cystamine, and a combination of mexamine with cystaphos in the case of repeated irradiation of mice at sublethal doses of x rays. The degree of the protective effect of the compounds studied was from 40 to 79%, depending on the time interval between influences. The total dose of irradiation had a substantial influence on the manifestation of the protective action of radioprotectors. The time interval between irradiations had no effect on the protective action of radioprotective agents, with the exception of cystaphos in which an increase in the protective effect with increasing time between irradiations was noted. One of the factors that lowered the effectiveness of the protectors in the case of repeated irradiations was an increase in their toxic action. (tr-auth)

Radiation Sickness and Injuries

Refer also to abstract 44948.

XUM

44840 (COO-1787-12) STUDY OF THE TRANSLOCATION OF PLUTONIUM AND AMERICIUM FROM PUNCTURE WOUNDS. Summary Report, April 1, 1968-June 15, 1971. Watters, Robert L.; Lebel, Jacques L. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 25 Jun 1971. Contract AT(11-1)-1787. 64p. Dep. NTIS.

Results are summarized from a three-year study of the translocation of ^{241}Am and Pu from puncture wounds. Simulated contaminated puncture wounds were obtained in beagle dogs by injecting plutonium in chemical forms of the types handled at Rocky Flats. These included air oxidized plutonium, plutonium nitrate, and high fired plutonium oxide (850°C). In each experiment half of the animals received intravenous injection of DTPA while the other half was untreated. Wound site excision took place only when there was evidence that the injected radionuclide was leaking from the wound site. During the time of the experiment, samples of urine, feces, and blood were collected routinely and, as the dogs were serially killed, blood and tissue samples were taken. Chemical assays for plutonium and ^{241}Am in excreta, blood, and tissues were performed, in vivo measurements were made using scintillation and solid state diode detectors, and samples for histopathologic study were taken at necropsy from the tissues to be assayed. One of the dogs in the first experiment developed lymphosarcoma and, as a result of this event, ten dogs were implanted for long term observation of lymphosarcoma induction. In vivo counting of the lymph node proximal to the implants showed a rapid and relatively high deposition in the node. This prompted a study of the effect of removal of the node upon the translocation and distribution of the plutonium in different chemical forms. (auth)

44841 CLINICAL ASPECTS OF ACUTE RADIATION INJURY. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.); Haley, T. J. pp 169-74 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A discussion is presented of factors to be considered in a consideration of clinical aspects of acute radiation exposure such as radiation dose, dose distribution in space and time, and relative biological effectiveness. Physiological responses to doses of ten to 10,000 rad are described. The following syndromes produced by whole-body exposure are discussed: central nervous system syndrome; gastro-intestinal syndrome; and hemopoietic syndrome. Practical clinical considerations in the diagnosis and therapy of radiation injury are discussed. (H.L.W.)

44842 EXPERIMENTAL BASIS FOR THE THERAPY OF RADIATION INJURY TO THE HAEMOPOIETIC SYSTEM. van Bekkum, D. W. (Organization for Health Research TNO, Rijswijk, Netherlands). pp 317-32 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A review of factors determining the take of hemopoietic cell grafts includes discussions of graft versus host reactions and quantitative requirements for a take of allogeneic bone marrow. In a review of bone marrow auto- and isografts the following topics are discussed: isogeneic bone marrow transplantation in animals pretreated with lethal doses of cytostatic drugs; number of isogeneic cells required to prevent death from the radioinduced bone marrow syndrome; and clinical application of autologous bone marrow as an adjunct in treatment with whole-body radiation or chemotherapy. It is concluded that humans require at least 1×10^8 isogeneic or autologous bone marrow cells for effective restoration of the hematopoietic tissues. For practical purposes 2×10^8 cells/kg body weight is recommended as a safe dose permitting a rapid restoration. Other topics discussed are: factors determining take of allogeneic bone marrow; use of spleen, leukemoid blood, and fetal liver as sources of hemopoietic cells for restoration of aplastic patients; use of frozen hemopoietic cells; and hemopoietic stem cell concentrates. (H.L.W.)

44843 CLINICAL RECOMMENDATIONS. Fliedner, T. M. (Univ., Ulm, Ger.). pp 333-8 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

In the case of acute radiation syndrome in man non-medical personnel generally expect a precise prognosis and therapeutic outline soon after exposure, in contrast to the usual systematic and continuing analysis of a disease that is expected of a physician. There is no justification for hasty therapeutic procedures done without careful consideration. It will be apparent within hours or days whether the exposure was so low that no elaborate therapy will be required or so high that no therapy will help. For patients in the intermediate exposure ranges days and even weeks will pass before a need for therapy may exist and therefore a careful diagnostic approach and the readiness for repeated adaptation of the management to new findings are essential before the prognosis can be evaluated. In many patients statements on prognosis must be extremely guarded for weeks. The most challenging therapeutic problem is related to depression of bone marrow and its consequences produced by pancytopenia. The need for therapy and the time at which it should be considered are related to the depletion of peripheral blood elements and to the time at which depletion occurs. A general guide for the diagnostic approach and its therapeutic consequences are given. It should be mentioned that the precise radiation dose will rarely if ever be known at the time the victim first consults a physician. Very often the determination of the physical dose may take days or weeks and may require an elaborate reconstruction of the incident. Thus, the physician has to rely on his usual methods for a careful analysis. A few guidelines can, however, be given that are based on the conclusions drawn from previous accidents and their management. The first goal for the evaluation of a person who is supposed to have been exposed to ionizing radiation is to establish as soon as possible whether his survival is "probable" or "possible" or "virtually impossible". It will take no more than 5 or 6 days to be certain into which of these categories a patient will fit, but within 2 days a great deal of valuable information can be obtained. Symptoms are classified according to the number of days after exposure into the following groups: 1 to 4 days after exposure; 5 to 12 days; 13 to 20 days; 21 to 35 days; and 36 to 45 days. Changes in the cardiovascular and gastrointestinal systems are discussed and therapeutic measures are recommended. A schematic outline of diagnostic approaches and therapeutic measures for the five time intervals is presented. (H.L.W.)

44844 EXPERIMENTAL AND CLINICAL JUSTIFICATION FOR USING PLASMA AND ITS FRACTIONS IN THE TREATMENT OF RADIATION SICKNESS. Fainshtein, F. E. (Central Inst. of Haematology and Blood Transfusion, Moscow); Agranenko, V. A. pp 339-55 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Existing literature on the use of plasma in radiation lesions is summarized and prospects are outlined for including individual preparations made from it in a comprehensive program for treating such lesions. A brief analysis of some of the work published on the use of blood, erythrocyte, leukocyte and thrombocyte transfusions in the treatment of radiation lesions is presented. It has been possible to demonstrate that at the stage which studies relating to blood transfusions, transfusions of blood components and plasma preparations have now reached, it is clearly necessary to differentiate in one's approach to their clinical application. It is quite obvious that despite numerous experimental and clinical studies further clarification is still required on many aspects of this problem of radiation sickness haemotherapy which is of such great interest today. This applies in particular to the specific ways in which various blood transfusion agents affect the course of the disease, the policies to be followed in prescribing them and the closely related mechanisms underlying the therapeutic effect observed. It follows from the data given that blood plasma and preparations derived from it, which are the chief concern of this chapter, are of definite importance in the treatment of radiation traumas. In applying these forms of treatment—like other haemotherapeutic agents—due regard must be paid to the specific features characterizing the clinical course of the sickness. For combatting toxicosis there is good reason to use agents with selective detoxicating action. Plasma transfusions undoubtedly help to reduce or stem radiation toxaemia and the application of albumin and "protein solution" also deserves consideration in this respect. The haemotherapeutic agents listed, all of which are capable of maintaining haemodynamic equilibrium, may be prescribed even when signs of shock are present. Since it frequently happens that at the end of the third or in the fourth stage of radiation sickness progressive hypoproteinaemia, along with other symptoms, looms large in the overall clinical picture, there are indications for the use of plasma, albumin and protein-solution transfusions. Whenever an increasing tendency to haemorrhage enters into the clinical picture of the disease the use of plasma and fibrinogen transfusions is justified. Naturally they should only be prescribed in this case on consideration of their potentially beneficial effect on the disturbances occurring in the blood coagulation system. The question of indications for the use of gammaglobulin, hyperimmune antistaphylococcal plasma and antistaphylococcal gammaglobulin, together with thrombin, fibrin films and haemostatic sponges as forms of treatment for radiation sickness is considered. (auth)

44845 DEPENDENCE OF THE THERAPEUTIC EFFECT OF HETEROLOGOUS DNA IN ACUTE RADIATION SICKNESS OF DOGS

ON THE DOSE OF THE PREPARATION. Rogacheva, S. A.; Luzanova, O. V.; Klyzhuk, K. N.; Sharova, E. G.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 106-13(Jan-Feb 1971). (In Russian).

When high-polymer heterologous DNA is administered to lethally irradiated dogs at doses of 5, 10, and 15 mg/kg, the largest increase in the survival rate (up to 70% in comparison with 20% in the control) was noted at large doses of DNA; at a dose of 5 mg/kg, 40% of the animals survived. Clinical observations and hematological investigations also indicated a greater effectiveness of high doses of the biopolymer. The possible mechanisms of early post-radiation restoration of hematogenesis under the influence of exogenous DNA are discussed. (tr-auth)

Radiodiagnosis

Refer also to abstracts 44601, 44754, and 44901.

44846 PATHOLOGICAL RENAL FUNCTION IN THE ISOTOPE NEPHROGRAM DURING PREGNANCY AND POST PARTUM. Tulzer, H.; Janisch, H.; Hernuss, P. (Univ., Vienna). Wien. Klin. Wochenschr.; 83: No. 19, 339-41(14 May 1971). (In German).

Exact localization of the kidneys was obtained at one hour following injection of 20 μCi of ^{197}Hg neohydrin. Renograms were then obtained following injection of 25 μCi of ^{131}I hippuran. Examinations were performed on 328 patients during pregnancy and post partum. In 151 of the patients, abnormal renograms were obtained; of these, 119 involved excretion, 30 showed impaired tubulo-secretory function, and two revealed renal aplasia. It was concluded that isotope renography represents an important and innocuous tool for the detection of kidney diseases in obstetrics. (H.B.G.)

44847 ESTIMATION OF RADIOISOTOPE DIAGNOSIS OF SKELETAL TUMORS. Knysh, I. T.; Mechev, D. S.; Tolstopyatov, B. A. (Inst. of Experimental and Clinical Oncology, Kiev). Vop. Onkol.; 17: No. 4, 29-36(1971). (In Russian).

The results of ^{32}P radiodiagnosis of patients with skeletal tumors are reported. To use ^{32}P for deep-seated skeletal tumors was found not to be feasible since it resulted in a great number of diagnostic errors. Strontium-85 was employed clinically in 230 patients with skeletal tumors (147 patients with malignant tumors, 43 with benign, 32 with non-tumor skeletal lesions, and 8 with soft tissue tumors). High-rate of accumulation of this isotope in tumor tissue during 7 days of investigation proved the malignant character of the neoplasm. It was concluded that variations in this isotope accumulation and its excretion from tissues could be successfully used in complex investigation of patients for purposes of differential diagnosis. (auth)

44848 RADIOISOTOPE DIAGNOSIS OF BONE TUMORS. Gabuniya, R. I.; Bizer, V. A. (Inst. of Medical Radiology, Moscow). Vop. Onkol.; 17: No. 4, 36-41(1971). (In Russian).

For diagnosis of bone tumors strontium-85 and ^{131}I labeled albumin of blood serum were employed. Accumulation of strontium-85 was observed both in benign and malignant tumors irrespective of the predominance of osteolytic or osteoblastic processes. The accumulation in malignant tumors exceeded that in benign tumors; this made it possible to use accumulation findings as an accessory test in establishing the differential diagnosis between benign and malignant tumors. Investigations with ^{131}I labeled albumin demonstrated various rates of accumulation of this agent depending on the character of the tumor. However, the data obtained rendered it unfeasible to determine whether the disease was of inflammatory or tumorous nature. (auth)

44849 EARLY DIAGNOSIS OF AFFECTION OF THE KIDNEYS IN DIABETES MELLITUS WITH THE AID OF RADIOISOTOPIC RENOGRAPHY. Slavnov, V. N.; Efimov, A. S. Probl. Endokrinol.; 17: No. 3, 7-10(May-Jun 1971). (In Russian).

The functional condition of the kidneys in 163 patients suffering from diabetes mellitus was investigated by radioisotopic renography. Investigations were carried out with the aid of ^{131}I on a universal radiodiagnostic unit, URU-64. Radioisotopic renography revealed changes in the secretory and excretory functions of the kidneys in 48.5% of the diabetic patients. It was found that the leading factors in diabetic nephropathy were disturbances of the excretory function, the extent of which is taken into consideration in assessing the stage of affection of the kidneys. It was established that radioisotopic renography not infrequently permits the detection of changes in the kidneys before the appearance of clinico-laboratory shifts. (auth)

44850 ^{18}F UPTAKE WITHIN METASTATIC OSTEOSARCOMA OF THE LIVER. A CASE REPORT. O'Mara, Robert E.; Brettner, Alfred; Danigelis, James A.; Gould, Leo V. (State Univ. of New York, Syracuse). Radiology; 100: No. 1, 113-4(Jul 1971).

A case is presented in which ^{18}F scans demonstrated metastatic deposits in the liver from a primary osteosarcoma of the thigh. This was followed by radiographically demonstrable calcification of the liver deposits. The possible use of bone-seeking radionuclides is suggested for the preoperative evaluation of such patients. (auth)

44851 ^{111}In-LABELED TRANSFERRIN FOR THE DETECTION OF TUMORS. Goodwin, David A.; Goode, Richard; Brown, Larry; Imbornone, Carol J. (Veterans Administration Hospital, Palo Alto, Calif. Stanford Univ., Palo Alto, Calif.). Radiology; 100: No. 1, 175-9(Jul 1971).

Patients with a variety of head and neck tumors were studied by scanning with ^{111}In-labeled transferrin. Plasma disappearance half-time was approximately ten hours; much of the radioactivity appeared in the bone marrow that was outlined well on the camera images twenty-four hours after injection. Localization of the tumor was possible by scanning in 7 of 10 patients. (auth)

44852 SCINTIGRAPHIC DEMONSTRATION OF BLOOD FLOW IN TUMORS. Schenck, P. (Univ., Heidelberg). Therapiewoche; 21: No. 20, 1611-12; 1615-16(19 May 1971). (In German).

Within 50 seconds following the injection of short-lived isotopes, such as ^{99m}Tc, ^{87m}Sr, and ^{113m}In, scintigraphic tumor pictures are taken with an Anger camera. This technique permits a rapid and easy determination of blood flow through the tumor. Thus, indications concerning extent of the tumor and its vascularization can be obtained. (H.B.G.)

44853 METHOD FOR IMPROVEMENT OF PANCREAS SCINTIGRAPHY. Schnabel, K. (Univ., Heidelberg). Therapiewoche; 21: No. 20, 1619-20(19 May 1971). (In German).

Immediately following administration of 200 to 250 μCi of ^{75}Se methionine, pancreatic scintigrams were taken with a fast scanner through a 5 in. collimator. Positioning of the patient was of greatest significance. To prevent overlapping by the liver, the examining table was tilted 15° from the horizontal, and the patient was turned approximately 20° toward his right side. Special isotope procedures were applied in a few cases where positioning alone did not prevent overlapping by the liver or gastrointestinal tract. Overall, the technique yielded exact information about outline and structure of the pancreas in 78% of the patients. (H.B.G.)

44854 RADIOIODINE TEST AND THE CLINIC. Riemer, M.; Misri, H. (Univ., Heidelberg). Therapiewoche; 21: No. 20, 1622; 1625(19 May 1971). (In German).

Since 1957, thyroid uptakes have been performed with ^{131}I on 16,320 patients. Frequently, findings did not agree with the clinical picture and could not be taken as basis for treatment. Therefore, the free thyroxine index was calculated from T_4 and T_3 tests. The number of patients was too small to permit final judgement concerning the free thyroxine index; however, its excellent agreement with the clinical picture, especially with autonomous nodes, was so encouraging it justifies further investigation. (H.B.G.)

44855 DOUBLE TRACER SCINTIGRAPHY WITH THE ANGER CAMERA. Lange, D.; Schenck, P.; Schnabel, K.; Ammann, W.; Scheer, K. E. (Univ.; Heidelberg. Institut fuer Nuklearmedizin, Heidelberg). Therapiewoche; 21: No. 20, 1606; 1609-10(19 May 1971). (In German).

A technique is described in which two radioisotopes are administered simultaneously for diagnostic purposes. With respect to energy, the Anger camera possesses such a high resolution that the two isotopes can be clearly separated. Therefore, it is possible to measure simultaneously both morphology and function of organs. Diagnosis of a brain tumor is described with the combination of ^{113m}In-labeled HSA and ^{99m}Tc-labeled pertechnetate. (H.B.G.)

44856 CLINICAL RENAL FUNCTION TESTING BY EXTERNAL DOUBLE ISOTOPE MONITORING TECHNIQUE. Pedersen, J. Fog; Pedersen, M. Fog; Madsen, Paul O. (Veterans Administration Hospital, Madison, Wis. Univ. of Wisconsin, Madison). Nucl.-Med.; 10: No. 1, 16-24(30 Apr 1971).

An accurate catheter-free technique for clinical determination simultaneously of glomerular filtration rate and effective renal plasma flow by means of radioisotopes was developed. The renal function was estimated by the amount of radioisotopes necessary to maintain a constant concentration in the patient's blood. The infusion pumps are steered by a feedback system, the pumps being automatically turned on when the radiation measured over the patient's head falls below a certain preset level and turned off when this level is again reached. ^{131}I-iodopyracet was used for the estimation of effective renal plasma flow and ^{125}I-iothalamate

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estimation of the glomerular filtration rate. These clearances were compared to the conventional bladder clearances and good correlation was found between the two clearance methods (correlation coefficients 0.97 and 0.90 respectively). The advantages and disadvantages of this new clearance technique are discussed. (auth)

44857 SIMULTANEOUS DOUBLE ISOTOPE INVESTIGATIONS IN FUNCTIONAL STUDIES. I. MATHEMATICAL DESCRIPTION FOR THE QUANTITATIVE EVALUATION. Lange, D.; Schenck, P. (Univ., Heidelberg). Nucl.-Med.; 10: No. 1, 25-38(30 Apr 1971). (In German).

A mathematical description is given for the time-dependent uptake of a radioisotope or radiopharmaceutical registered with external detectors. If blood flow and intravascular volume of the tissue investigated are known, the extraction index can be calculated. Both blood flow and intravascular volume are seldom evaluable with the cleared isotope itself nor is a control of both parameters possible. A second isotope must be simultaneously administered. In the special case of a time-constant clearance the mathematical formula yields the known relations between extraction index or clearance and the decay constant of blood activity. Mathematical solutions are given for the normal case of time-dependent clearance for one or two simultaneously applicated isotopes. Because the efficiency of the Anger-camera is nearly independent of the distance of activity and furthermore the morphologic image allows organ-specific investigations of the clearance or the extraction index, it is suggested that the double tracer technique with this instrument might be of clinical value. (auth)

44858 POSTURAL CHANGES IN ESSENTIAL HYPERTENSION UNDER TREATMENT AND THEIR EFFECT ON THE RENOGRAM. Darsinos, J.; Alexandrou, C.; Papadakis, E.; Gyftaki, E. (Univ. of Athens. Alexandra Hospital Radioisotope Lab., Athens). Nucl.-Med.; 10: No. 1, 39-46(30 Apr 1971).

Radioisotope renograms were obtained in the upright and prone position in 9 normal subjects, in 5 patients with untreated hypertension, and in 21 hypertensives under treatment, showing moderate postural hypotension. No significant renographic changes were seen in the two positions in normal subjects and untreated hypertensives. Treated hypertensives with postural hypotension showed significant impairment of renal function in the upright position in 15 cases and no change in 6. Renal creatinine clearance was lower in the group that showed renographic changes. Renography in the upright position is suggested as a convenient test for early diagnosis and follow-up of the adverse effects of antihypertensive treatment. (auth)

44859 IMPORTANCE OF THE LATERAL LIVER SCAN. Weiss, Edward R. (Veterans Administration Center, Los Angeles. Univ. of Southern California, Los Angeles); Blahd, William H. Nucl.-Med.; 10: No. 1, 47-54(30 Apr 1971).

Radioisotope photoscanning of the liver is an important screening procedure for the detection of localized intrahepatic and extrahepatic diseases. The diagnostic accuracy of the procedure can be greatly enhanced by the routine use of the right lateral view as well as the standard anterior view. Selected cases are presented to illustrate the value of the right lateral view in liver photoscanning. (auth)

44860 INFLUENCE OF RECIRCULATION ON MYOCARDIAL CLEARANCE CURVES WITH ^{133}Xe. Holmberg, S.; Luepker, R.; Varnauskas, E. (Sahlgrenska Sjukhuset, Goteborg). Acta Med. Scand.; 189: 241-50(1971).

Myocardial clearance curves with inert radioactive gas as indicator regularly deviate from monoexponential curves. When ^{133}Xe is used as an indicator and injected into the left heart the major part is removed from circulation by effective alveolar ventilation, while a minor fraction re-enters the left heart and recirculates through all vascular beds including the coronary vascular system. The effects of this recirculation on the shape of the myocardial clearance curve were investigated under conditions when deviation is especially pronounced, i.e. pacemaker-induced tachycardia. Tachycardia caused increased coronary flow with steeper clearance curve, while the ventilation and hence the amount of recirculating Xenon was unchanged. The resulting marked deviation was significantly diminished by voluntary hyperventilation, which decreased the recirculation. This explains the decrease of deviation during physical exercise when both coronary flow and effective alveolar ventilation increase. The error imposed by recirculation on the calculation of coronary flow is on the average less than 5% during pacemaker-induced tachycardia. (auth) (Sweden)

Radiotherapy

Refer also to abstracts 44803, 44955, and 45839.

44861 APPLICABILITY RANGE OF ENDOLYPHATIC RADIOISOTOPE THERAPY WITH ^{32}P IN MALIGNANT DISEASES OF THE LYMPHATIC SYSTEM. Kaercher, K. H.; Wolf, G. (Univ., Vienna). Wien. Klin. Wochenschr.; 83: No. 20, 360-2 (21 May 1971). (In German).

Following endolymphatic administration, commonly used doses of 4 μCi ^{32}P produce 70,000 to 80,000 rad in the lymph nodes of limbs. This type of treatment was performed on 96 patients either with primary disease of the lymphatic system or metastatic involvement. Among the former group, Hodgkin's disease was prevalent while the latter group comprised mostly malignant melanoma and testicular malignancies. Efficacy and side effects of the treatment are discussed. (H.B.G.)

44862 USE OF RADIOACTIVE PHOSPHORUS IN CANCER METASTASES IN BONES AND MYELOMA. Kantin, A. V.; Lapchenkov, V. I.; Shvartsberg, E. M. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 17: No. 4, 46-50(1971). (In Russian).

Radioactive phosphorus ^{32}P was applied in 54 patients with cancer metastases in bones and in 28 patients with myeloma. Fifty-seven patients received 1 μCi of this agent per week (a total dose of 5 to 11 μCi). Twenty-five patients received 3 μCi within the same period (a total dose of 6 to 12 μCi). The immediate and early (up to 18 months) observations showed that due to radioactive phosphorus therapy intensive pains either disappeared or a markedly general improvement was noticed and the process of metastases proliferation became retarded. Dosimetric investigations demonstrated, however, the inadequacy of radiation effect on tumor elements while using the mentioned doses, that could not completely break down metastases, but somewhat retard the process of dissemination. The use of large fractionation seemed to be more rational than a small one. (auth)

44863 TOTAL-SKIN ELECTRON TREATMENT OF MYCOSIS FUNGOIDES. Fuks, Zvi; Bagshaw, Malcolm A. (Tel Aviv Univ., Israel. Stanford Univ., Calif.). Radiology; 100: No. 1, 145-50 (Jul 1971).

Patients (107) with mycosis fungoides were treated by total-skin irradiation with 2.5 MeV electrons. Patients with localized disease experienced long and sustained remissions; 8 were free of the disease three to eleven years after their first and only course of electron irradiation. Most patients with widespread disease suffered a relapse within three years after their first treatment. It seems justified to refer patients with early and localized disease for total-skin electron irradiation. Potentially curative electron-beam therapy alone seems inadequate for patients with more advanced or widespread disease. (auth)

44864 ^{60}Co TELETHERAPY OF LOCALIZED PROSTATIC CARCINOMA: A 10-YEAR EXPERIENCE. Odell, R. W. Jr.; Merrill, M. D.; Attwood, C. J. (Samuel Merritt Hospital, Oakland, Calif.). J. Urol.; 105: No. 6, 843-6(Jun 1971).

Ten years of experience in treating localized carcinoma of the prostate with ^{60}Co radiation is reviewed. Long-term control with a survival rate of 58% at 9 years in this series compared well to other published results. It is believed that supervoltage or equivalent radiation can play a substantial role in the management of this disease. Its potential in the cure of localized prostatic cancer is discussed. (auth)

44865 ^{60}Co-TELETHERAPY IN CEREBRAL TUMORS. Schuetz, J.; Brands, Th.; Schachinger, P. (Westfaelische Wilhelms-Univ., Muenster, Ger.). Strahlentherapie; 141: No. 4, 367-74(Apr 1971). (In German).

The value of radiotherapy of cerebral tumors can be demonstrated only on the obtainable palliative success. In spite of the eminent modern radiotechnical possibilities, the results, measured by survival time, were unsatisfactory. The evaluated number of 227 intracerebral tumors was treated uniformally by ^{60}Co-teleradiation. In glioblastomas the survival rates, especially for whole-body irradiated patients, are a little better than was expected according to literature reports. None of the patients survived a 5 year period. For the rest of histologically verified tumors, the number of cases was not sufficient to allow a critical examination. The importance of a pathohistological examination was proved by the survival curve of patients with non-operated tumors, irradiated without previous histological classification. (auth)

44866 PROGNOSIS OF RECTAL CARCINOMA TREATED INITIALLY WITH ^{60}Co GAMMA AND ULTRA-HARD X RAYS OF THE BETATRON. Geginat, G. (Freie Univ., Berlin). Strahlentherapie; 141: No. 4, 375-80(Apr 1971). (In German).

By initial application of radiotherapy in carcinomas of the rectum and anus (clinical stages I and II of the TNM system)

a five year cure of 35% and a five year survival rate of 72% was observed. It is necessary to follow up on these very favorable results of the initial radiotherapy, since the group of patients was relatively small and the time of observation rather short. Compared with surgical intervention, radiotherapy of these cases had the advantage that an anus praeter could be avoided. Primary radiotherapy of carcinoma of the rectum (stage III and IV) induced a good palliation with amelioration of the clinical symptoms. However, the survival rate as compared with untreated patients was only moderately improved in stage III and not at all in stage IV. (auth)

44867 RADIOTHERAPY OF HODGKIN'S DISEASE: THE RESULTS OF THE RADICAL MEGAVOLT THERAPY WITH LARGE FIELDS IN COMPARISON WITH THE CONVENTIONAL ORTHOVOLT THERAPY. PART I. RESULTS ON THE TOTAL NUMBER OF PATIENTS IN FREIBURG FOR THE PERIOD FROM 1948 TO 1964 AND FROM 1964 TO 1969. Musshoff, K.; Kalkoff, P.; Strickstrock, K. H.; Boehmert, A.; Mayer, W.; Merten, D. (Univ., Freiburg i. B.). Strahlentherapie; 141: No. 4, 381-9 (Apr 1971). (In German).

The results of the treatment for Hodgkin's disease by orthovolt radiotherapy with limited fields were compared with the results of the megavolt radiotherapy (^{60}Co) with predominantly large fields and with a uniform application of a tumor annihilating dose. By using this new therapeutic method and including the total number of patients irrespective of their clinical stages, the 5 year survival rate could be raised from 42 to 66% and the 5 year rate of the first remission from 19 to 36%. (auth)

44868 CRITICAL EXAMINATION OF THE RADIOSENSITIVITY IN THE CANCER OF THE CERVIX. Dubrauszky, V.; Rotte, K. (Univ., Wuerzburg, Ger.). Strahlentherapie; 141: No. 4, 390-5(Apr 1971). (In German).

The radiosensitivity of cancer of the cervix was tested in 191 patients. Before treatment was started and eight days after application of a test radiation dose, biopsies from the tumors were taken and the histological alterations caused through this radiation were examined. The test dose was applied to the tumor in the form of a radium-contact irradiation. 800 to 1500 R proved to be the optimal dose. The radiosensitivity of a tumor is classified as follows: Excellent radiosensitivity (66 to 100% degenerative cells following application of the test dose); good radiosensitivity (33 to 65% degenerative cells); and poor radiosensitivity (1 to 32% degenerative cells). Control examinations performed 3 to 5 years after termination of radiotherapy showed that in the groups with excellent and good tumor radiosensitivity the healing rates were significantly higher, whereas in the group with poor radiosensitivity they were markedly lower than the average values. Possible therapeutic consequences from the results of sensitivity tests are discussed. (auth)

44869 CONTRIBUTION TO THE PROBLEM DOSE AND TIME. COMPARATIVE VOLUMETRIC EXAMINATIONS OF IRRADIATED METASTASES. Alth, G. (Univ., Vienna). Strahlentherapie; 141: No. 4, 396-9(Apr 1971). (In German).

By volumetric measurements, it was found that a single high dose is more effective for obtaining a reduction of the metastasis than a daily fractionated dose. With this method, the total tumor dose can be reduced by half or two-thirds depending on the case. (auth)

44870 STUDIES ON THE LONG-TERM SELECTIVE UPTAKE OF BORON BY TUMORS OTHER THAN BRAIN TUMORS: ITS POSSIBLE USE IN NEUTRON-CAPTURE CANCER THERAPY. Anghileri, Leopoldo J.; Miller, Esther S. (Veterans Administration Hospital, Denver). Strahlentherapie; 141: No. 4, 404-8(Apr 1971).

The long-term (72 hours) selective uptake of boron by tumors was studied in animals. The higher concentration in tumors indicated that the use of borates for neutron-capture cancer therapy is feasible. The low boron concentration can be improved by using an enriched $^{10}_{5}$B boron or by a series of low dosage administrations. (auth)

44871 ADDITIONAL INFORMATION OBTAINABLE FROM FIELD CONTROL PICTURES WITH GAMMA RADIATION. Wieland, C.; Hymmen, U. (Univ., Heidelberg). Therapiewoche; 21: No. 20, 1592; 1595-6(19 May 1971). (In German).

A decade of experience is described during which field size in ^{60}Co and ^{137}Cs therapy was measured through a direct control picture. The technique for obtaining this picture is outlined. Especially in the thorax area, the control pictures yield not only information about the field size but also about diagnosis which could not be obtained from routine x radiography. (H.B.G.)

44872 COMPARISON OF LARGE AND SMALL DOSES OF RADIOACTIVE ^{131}I IN THE TREATMENT OF PATIENTS WITH CARDIAC DAMAGE ASSOCIATED WITH THYROTOXICOSIS. Felt, V.; Vana, S.; Nemec, J.; Silink, C. (Research Inst. of Endocrinology, Prague). Nucl.-Med.; 10: No. 1, 55-68 (30 Apr 1971).

A comparison of the effects of large and small doses of ^{131}I in patients with cardiac thyrotoxicosis revealed that after large doses thyrotoxicosis recedes more rapidly but is associated with a high incidence of hypothyroidism in subsequent years. After small doses, the incidence of hypothyroidism is smaller; there is, however, a high percentage of persisting thyrotoxicoses. The sensitivity to radioiodine is higher in diffuse goiter, in small goiters, and after thyroidectomy. Large and small doses have approximately the same effect on the regression of decompensation and the incidence of paroxysmal atrial fibrillation, provided that treatment is supplemented by thyrostatic, antiarrhythmic, cardiotonic, and diuretic drugs. Larger doses of radioiodine had a more favorable effect on the reversion to sinus rhythm in patients with permanent atrial fibrillation. (auth)

44873 STUDY OF SIMULTANEOUS RADIOACTIVE GOLD AND CYTOSTATIC THERAPY IN THE TREATMENT OF MALIGNANT EFFUSIONS. Varma, K. D.; Schenck, P.; Lange, D. (Univ., Heidelberg). Nucl.-Med.; 10: No. 1, 69-76(30 Apr 1971).

A combination of ^{198}Au and cytostatic drugs appeared to give the best results in the treatment of malignant effusions. No correlation could be found between the type of tumor and the response to therapy. Asymptomatic patients seemed to respond better to either form of therapy. The lasting relief may occur after 6 to 12 instillations of cytostatic drugs following ^{198}Au therapy. The longest relief experienced in the present study lasted 2 years and 4 months and occurred after a single application of ^{198}Au. (auth)

44874 PRINCIPLE OF THE CALCULATION OF DEPTH DOSE IN ^{60}Co-TELEGAMMA IRRADIATION. Popp, Fritz A.; Hoffmann, Johanna (Univ., Marburg, Ger.). Strahlentherapie; 141: No. 5, 612-19(May 1971). (In German).

It is proposed to facilitate the application of a calculation method for the dose distribution in ^{60}Co-depth therapy by correlating the essential relations of this procedure with the frame of the entire calculation program. Without a considerably larger amount of calculation in comparison with the procedure of Richter and Schirrmeister this method takes into consideration the dependency of the rescattered rays on the depth and on the proportion of the sides of the rectangular fields. In addition to that, this method will save measuring scattered rays. The differences in the calculated distribution of the depth dosage between this method and the one of Richter and Schirrmeister demonstrate that the latter procedure is problematic when rectangular fields with high side-proportions are used. (auth)

44875 PENDULUM IRRADIATION OF URINARY BLADDER WITH ^{60}Co. Bunde, Erich; Czempiel, Heinz (Univ., Munich. Staedtische Krankenhause, Munich). Strahlentherapie; 141: No. 5, 620-31(May 1971). (In German).

Difficulties in obtaining a satisfactory dose distribution for the irradiation of bladder carcinomas are discussed, and measurements of the bladder localization are reported, as well as dose distribution measured in different phantoms with ionization chambers, LiF rods, and films. The measurements showed that in most cases the 80% isodoses should have a 6.5 to 10 cm width, 6.5 to 11 cm anterior posterior, and a length up to 12 cm, for an axis of these isodoses lying at a depth of 6 to 9.5 cm; these conditions are fulfilled for a pendular irradiation with telecobalt over 120 to 180°. A work table is described presenting the various parameters of the irradiation according to chosen depth and width of the isodose. Furthermore, the calculation of the irradiation time according to the patient's dimensions is discussed. The importance of an accurate localization and of a comparable filling state of the bladder during localization and irradiation is stressed. (auth)

44876 DOSE MEASUREMENTS IN OESOPHAGUS IN ^{60}Co ROTATION THERAPY. McEwan, A. C.; Wheeler, T. K. (Cambridge Univ., Eng. Addenbrooke's Hospital, Cambridge, Eng.). Acta Radiol., Ther., Phys., Biol., 9: 618-21(1970).

A method is described for measuring the variation in tumor dosage, which differs from a prescribed plan, using thermoluminescent lithium fluoride microrod dosimeters. Two representative cases are considered in detail. (auth) (Sweden)

44877 DISTRIBUTION OF SCATTERED RADIATION ON THE SURFACE OF A PATIENT'S BODY DURING RADIOTHERAPY. Durkovsky, J.; Laginova, V. (Slovak Oncological Inst., Bratislava). Cesk. Radiol.; 25: No. 1, 1-6(Jan 1971). (In Slovak).

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Measurements of radiation doses were carried out on a phantom to determine the distribution of scattered radiation from the primary beam in the body of patients during radiotherapy. Some data on the distribution of radiation dose on the surface of the phantom during ^{60}Co gamma-teletherapy and conventional x-ray therapy are presented. The feasibility of applying the results of measurements in clinical practice is discussed. (INIS)

44878 MEASUREMENT OF RADIATION DOSES IN VIVO DURING RADIOTHERAPY OF GYNECOLOGICAL CARCINOMA. Kiviniitty, K.; Kauppila, A.; Vehaskari, A. (Oulu Univ., Finland). Strahlentherapie; 141: No. 4, 400-3(Apr 1971).

Measurements with a gammameter form a suitable basis for clinical work in radiotherapy. Additional information from LiF measurements made during radiotherapy of gynecological carcinomas can be valuable in cases in which doses to the urinary bladder or rectum were high in previous radium application, and in cases in which the anatomical conditions present difficulties. In telecobalt treatment, LiF measurements are useful if a high total dosage is desired, especially for patients who received high doses to the urinary bladder and the rectum during earlier radiotherapy. A disadvantage of the LiF measurements is that they require analysis, which is very time-consuming. Moreover, the measurement catheter cannot always be placed at the site desired, and in such cases it is impossible to obtain the exact total dose to the maximum point. By taking LiF measurements together with isodose curves, and measurements with a gammameter, it is possible to obtain reliable information about the radiation doses to the urinary bladder and the rectum during both radium and external irradiation. (auth)

44879 COMPUTER PROGRAM FOR DOSE DISTRIBUTIONS IN TELETHERAPY WITH ^{60}Co. Leetz, Hans-Karl (Univ. des Saarlandes, Homburg, Ger.). Strahlentherapie; 141: No. 4, 416-20(Apr 1971). (In German).

Mathematical foundations are elaborated for a ^{60}Co teletherapy computer program. Included are: radiation field-coordinate system and dose formula; coordinate system in the patient cross section and calculation of variables for the dose formula; corrections for inhomogeneities; consideration of uneven radiation entrance plane; correction for wedge filter; and movable radiation source. (H.B.G.)

44880 STUDIES ON THE DYNAMICS OF INCREASED TISSUE BLOOD FLOW DUE TO SWIERADOW RADIOACTIVE BATHS. EFFECTS OF PREMEDICATION WITH SYMPATHOLYTICS. Lukasik, Seweryn; Halawa, Bogumil; Rog-Malinowski, Miron. Pol. Tyg. Lek.; 25: 1799-1801(Nov 1970). (In Polish).

By use of the isotope method with radioactive xenon, the behavior of tissue blood flow was studied after one radioactive bath following previous premedication with dihydroergotamine, propranolol, or both these drugs jointly. It was observed that a single bath without sympathicolytic premedication increased the tissue blood flow by nearly 400% as compared with the effect obtained after a usual bath that was treated as a blind test. Premedication with dihydroergotamine and propranolol prevented the development of the effect of radioactive bath while premedication with propranolol only decreased the blood flow only slightly. It is believed that the effect of radioactive baths is obtained by their direct or indirect action on the adrenergic nerve endings. (auth)

Blast and Thermal Effects

Refer also to abstracts 44951 and 44952.

Radiation Effects on Animals

Refer also to abstracts 44788, 44819, and 44880.

44881 MODELS RELEVANT TO RADIATION EFFECTS ON STEM CELL POOLS. Lajtha, L. G. Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 151-7 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

Kinetic concepts of the following models of stem cell populations are described: Osgood model ($\alpha-2\alpha$), Lajtha model (G_0), Newton's model, Kretchmar model, and Till model. Discussions are presented of the following topics: inhomogeneity of the stem cell populations; growth characteristics of colony-forming cells; stem cell kinetics during chronic irradiation; and autorepopulation. An attempt is made to correlate the cell populations involved in normal hemopoiesis and their reaction to an irradiation regime. (H.L.W.)

44882 EXPERIMENTAL APPROACHES TO THE STUDY OF RADIATION EFFECTS ON HAEMOPOIETIC STEM CELLS. Silini, G.; Pozzi, L. V. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 159-66 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

The following methods for estimating hematopoietic stem cells are discussed: spleen-colony assay; in vitro cloning of hematopoietic cells; methods based on the uptake of ^{59}Fe; methods using the uptake of other radioactive labels; and methods based on the survival of irradiated animals. The radiation response of hematopoietic stem cells is discussed with regard to cell survival, recovery from sublethal damage, and repopulation of the stem cell compartment. In conclusion, the general picture of post-irradiation repopulation of haemopoietic stem cells seems now reasonably established. Technical inadequacies inherent to the various titration procedures may alter the actual numerical values in each single experiment, but the general trend is probably the following: after an early period lasting about 1 day during which repair of sublethal damage takes place, as shown in the preceding paragraph, a rapid numerical increase of the stem cell population is observed; during this phase the ratio of cycling to non-cycling stem cells is probably shifted in favor of the cycling component; the overall doubling time of the stem cells in the spleen during exponential growth may vary between 32 and 20 hours, with most common observations around the shorter times; expansion of the stem cell pool takes place at different rates in different tissues. In the spleen growth proceeds faster and reaches values above normal. This condition may persist for several weeks, but eventually the number of stem cells returns to normal levels. (H.L.W.)

44883 MECHANISMS OF THE DIFFERENT RADIORESISTANCE OF MAMMALIAN CELLS CULTURED IN VITRO. Bekeneva, G. P.; Parkhomenko, I. M.; Burlakova, E. V. (Moscow State Univ.). Radiobiologiya; 11: No. 1, 48-52(Jan-Feb 1971). (In Russian).

The radiosensitivity of TMN and MT monkey cells, cultured in vitro, was investigated. Experiments with acriflavin, an inhibitor of postradiation recovery, indicated that the small differences in recovery cannot explain the substantial differences in the radioresistance of TMN and MT cells. A positive correlation was detected between the radioresistance of TMN and MT cells and their content of endogenous SH-groups. The highest level of acid-soluble SH-groups corresponds to the radioresistant point (late S) in the mitotic cycle of TMN cells. (tr-auth)

44884 SKETCHES ABOUT A BIOCHEMICAL AND SYSTEMIC THEORY OF RADIOINDUCED DISTURBANCES OF MITOSIS. Kaufmann, Horst (Ruhr-Univ., Bochum, Ger.). Strahlentherapie; 141: No. 4, 439-45(Apr 1971). (In German).

A theory of radioinduced disturbances of mitosis was developed based on literature review and experimental results. A disorder of nuclear spindle through blocking of the SH-groups was assumed as the cause of the irreversible stop of mitosis. The first phase of the reversible inhibition of mitosis (diminution of mitoses, primary effect of G2-M-blockage) was attributed to the disturbance of an energy store (leak and trouble of the fill up-mechanism); the relation between dose and duration of the amitotic (or pauperomitotic) interval was thought to be caused by the known disorder of the DNA-synthesis (S-G2-blockage). Both disturbances were then understood as being disorders of the energy providing process. As the disorder of cellular energy must be removed before resumption of mitosis, the problem of time-relation of the recovery processes in different levels is discussed. (auth)

44885 AUGMENTATION OF RADIOSENSITIVITY IN MAMMALIAN CELLS THROUGH SYNCHRONISATION OF THEIR DIVISION CYCLE WITH FRACTIONATED X-RAY TREATMENT. Prevot, H. Jr.; Schneider, C.; Linden, W. A.; Brunkhorst, H.; Luegger, A. (Univ., Hamburg. Strahleninstitut, Hamburg). Strahlentherapie; 141: No. 4, 446-50(Apr 1971). (In German).

Cells of mammals of strain L-929 were synchronized in their cycle of division. After synchronization, a radiation dose of 240 rad was applied at different moments. The change of the capability to form colonies of single cells was regarded as a standard for radiation damage. This was most distinct, if irradiation was applied immediately before mitosis during the G2-phase. A further period of elevated radiosensitivity was noted during the S-phase. Through synchronization with low x-ray doses most of the homogenous cells in a determinable moment were brought contemporarily in a radiosensitive period of the G2-phase. By means of the synchronization method described, which seems to be applicable in vivo as well, radiosensitivity of the cells could be increased considerably. (auth)

44886 CYTOMORPHOLOGICAL EXAMINATIONS OF A MODIFIED IRRADIATION EFFECT BY OXYGEN ON TUMOR CELLS IN TISSUE CULTURE (HeLa CELLS). Scherer, Eberhard; Teske, Hans-Juergen; Kuwert, Ernst; Gronemann, Annegret (Ruhr Univ., Essen). Strahlentherapie; 141: No. 5, 591-8(May 1971). (In German).

Quantitative cytomorphological examinations of HeLa cells after a single x irradiation of 500, 1000, and 3000 R in oxygen or deoxygenated nitrogen were conducted. Determination of the rate of pycnosis and the quantity of mitoses and giant cells followed 1, 24, 96, and 168 hours after irradiation. The rate of mitoses decreased immediately after irradiation and increased beyond the initial value 24 hours later. The quantity of pycnosis as well as that of the giant cells increased from the 1st to the 168th hour depending on dose. All phenomena were more marked during irradiation with oxygen than without oxygen. The giant cells formed in oxygen after irradiation were more commonly mononuclear than the cells in nitrogen which were more commonly multi- or polynuclear. (auth)

44887 MODIFICATION OF RADIATION DAMAGE IN THE CASE OF INHIBITION OF DNA SYSTHESIS. Gotlib, V. Ya.; Pelevina, I. I.; Afanas'ev, G. G.; Lipchina, L. P. (Inst. of Chemical Physics, Moscow). Radiobiologiya; 11: No. 2, 163-9(Mar-Apr 1971). (In Russian).

The treatment of a culture of LL cells with a nontoxic concentration of hydroxyurea (HU), a specific inhibitor of DNA synthesis, led to a change in their radiosensitivity. HU ($1 \cdot 10^{-4}$ M) induced protection or sensitization, depending on the duration of the influence and the moment of addition. It is suggested that a necessary condition in the appearance of the sensitizing effect is a change in the molecular structure of the DNA, while inhibition of DNA synthesis apparently does not play any significant role. The protective action in the case of postradiation treatment of the cells with HU may be associated with an increase in the time for restoration of damages in the case of inhibition of DNA synthesis. (tr-auth)

Invertebrates

Refer also to abstracts 44804 and 44978.

44888 (RLO-2225-T-1-8) COLUMBIA RIVER STUDIES ANNUAL PROGRESS REPORT, 1970-1971. (Washington Univ., Seattle. Lab. of Radiation Ecology). 30 Jun 1971. Contract AT(45-1)-2225. 12p. Dep. NTIS.

Data are reported from laboratory studies on the additive effects of thermal shock (up to 46°C) and ionizing radiation on the survival of oyster larvae. Chronic irradiation of developing larvae was carried out by the addition of ^{3}H or ^{65}Zn at concentrations of 10^{-4} to 10^{-3} Ci (approximately 1 rad) to the rearing water in which the larvae remained until 48 hrs after fertilization. Larvae were also exposed to 10 R doses of x radiation. The irradiated and thermal-shocked larvae were reared at 20, 24, and 28°C and then examined for frequency of abnormal larvae, rate of development, and survival. No additive effects of ionizing radiation and temperature were observed. The effects of thermal shock, γ radiation, and thermal shock plus ionizing radiation on primary production in aquatic plants were studied by measuring the utilization of carbon during photosynthesis in pure cultures of Chlamydomonas reinhardi and Monochrysis lutheri and mixed phytoplankton species. There was no recovery in primary productivity from thermal shock, but in most cases productivity was stimulated by small temperature increases. Doses of γ radiation ranging from 50 to 400 krad caused a decrease in carbon utilization. The biological half-life of Hg and Zn in oysters was measured using ^{203}Hg and ^{65}Zn as tracers. The content of ^{65}Zn in mussels was used to monitor Hanford-produced radioisotopes in the Columbia River. Thermoluminescent dosimeters consisting of two pieces of LiF sealed in plastic were used to measure background radiation doses in Columbia River bottom sediments and to living oysters. (C.H.)

44889 STUDY OF CHANGES IN THE FERTILITY OF ORPHAN WORKERS OF THE ANT DOLICHODERUS QUADRIPUNCTATUS IRRADIATED WITH X AND γ RAYS. Torossian, Claude (Univ., Toulouse). Compt. Rend., Ser. D; 272: No. 7, 966-9 (15 Feb 1971). (In French).

Orphan workers of the ant Dolichoderus quadripunctatus were irradiated at doses between 1000 and 150,000 rads; it is found that these irradiation doses sterilize almost all the workers treated, the effects being all the more pronounced as the doses are high. The adult ants irradiated show great resistance and longevity while the ovary is much more sensitive. An x irradiation which causes no apparent reduction in life-time (at least for doses between 1000 and 1500 rads) leads to total and definitive sterility in a few days. Whatever the irradiation doses used, γ rays and x rays produce the same effect. (France)

44890 INCREASE OF REGENERATION POWER IN PLANARIA IRRADIATED TO LETHAL DOSES BY STIMULATION OF THE TYPE I CELL SYSTEM. Chandebois, Rosine (Univ., Marseille). Compt. Rend., Ser. D; 272: No. 10, 1417-19(8 Mar 1971). (In French).

Regeneration is incomplete in planaria sectioned immediately after a lethal irradiation and practically impossible in those sectioned 48 hours later. Well-developed regenerates and an increase in the time necessary for the inhibition of regeneration are obtained when the operation is carried out 3 days before irradiation. These experiments confirm the trophic role assigned to type I cells. (France)

44891 DEVELOPMENT OF RADIOSENSITIVITY DURING EMBRYOGENESIS OF COLORADO BEETLE (LEPTINOTARSA DECEMLINEATA SAY). Bluzat, Roger (Univ., Orsay, France). Compt. Rend., Ser. D; 272: No. 11, 1542-5(15 Mar 1971). (In French).

During the embryogenesis of Leptinotarsa decemlineata Say, there is a highly radiosensitive period, which occurs at the end of segmentation. Gastrulation is a relatively insensitive phase. Radioresistance increases exponentially during the second half of embryogenesis. (France)

Vertebrates

Refer also to abstracts 44755, 44761, 44763, 44764, 44766–44768, 44771, 44779–44782, 44805, 44807, 44826–44830, 44832, 44835, and 44845.

44892 (NYO-2785-5) TUMORIGENIC ACTION OF BETA, PROTON, ALPHA, AND ELECTRON RADIATION ON THE RAT SKIN. Progress Report, August 31, 1970–July 31, 1971. Albert, Roy E. (New York Univ., N. Y. Dept. of Environmental Medicine). Contract AT(30-1)-2785. 12p. Dep. NTIS.

Data are summarized from studies on the effects of single exposures to ^{91}Y β particles, x radiation, electrons at several energy levels, and charged α particles on the induction of tumors in rat skin. The effects of radiation dose, dose rate, LET, and the physiological condition of hair follicles at the time of irradiation on the rate of tumor induction were studied. A constant proportionality was observed between the incidence of atrophic follicles and tumors. The critical depth for tumor yield in rat skin was found to be 0.3 mm. (C.H.)

44893 RADIOBIOLOGICAL BASES FOR THE UNDERSTANDING OF THE HAEMATOLOGICAL CONSEQUENCES OF RADIATION EXPOSURE. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). pp 71-8 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

When the entire body is exposed to large doses of penetrating ionizing radiation, a complex series of effects and symptoms known as the "acute radiation syndrome" results (Bond et al., 1965). Following doses in the lethal range, defined as the dose range in which some so exposed will die during and some will survive beyond an arbitrary time period taken usually as 4 to 8 weeks, the "bone marrow" or "haematopoietic syndrome" is seen (larger doses lead to the "gastro-intestinal" and "central nervous system" syndromes). The primary object of this chapter is to show that the serious effects and symptoms are due to changes in the haemopoietic cell populations and that the changes are predictable on the basis of rather straightforward radiobiological principles that are derived from studies of radiation effects in tissue culture systems. The discussion will center principally around the effects of a single large dose of penetrating x or gamma radiation delivered uniformly to the entire body in a time scale of the order of seconds to at most a few hours. For purposes of orientation it should be pointed out that the median lethal dose of mammals for exposure to penetrating whole-body radiation varies by a factor of approximately 10, from approximately 150 to 1500 rads. Most large mammals have relatively small LD_{50}s of the order of 150 to 440 rads, and the LD_{50} for man is probably about 300 rads. Small mammals in general have a higher LD_{50}, ranging from approximately 600 to 1500 rads. The reasons for these differences are not known. (auth)

44894 MORPHOLOGICAL ASPECTS OF RADIATION INJURY. Congdon, C. C. (Oak Ridge National Lab., Tenn.); Fliedner, T. M. pp 85-8 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/123.

The injury to haemopoietic and lymphatic tissues produced by ionizing irradiation in various species of mammals including man is one of the major features of the biological effects of radiation. At the moment of injury and for a short time thereafter relatively

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little morphological evidence of cell damage in bone marrow other than cessation of cell division and DNA synthesis is seen. Within a few hours, however, depending on the level of exposure, major destruction of red bone marrow tissue can occur. In this chapter the histologic changes in bone marrow are summarized for correlation with the functional aspects of the change in the target tissue, particularly its cell renewal features and where possible the remarkable flux or migration of cells through bone marrow and lymphatic tissues. This latter topic of cellular traffic represents the outcome of extensive physiological studies on haemopoiesis and lymphopoiesis by mammalian radiobiologists. The initial injury, the structural changes and the physiological consequences are the first half of the radiation injury sequence. Regeneration also has morphological features of major importance to the understanding of radiation haematology. It is common to discuss radiation effects on biological materials from the point of view of external or internal sources of exposure. In addition exposure rate, whole body or partial body, type and quality of the ionizing source are features that must be taken into account. While these features are extremely important, the simplest approach to understanding histologic effects on the bone marrow is to assume acute penetrating whole-body exposure in the lethal range. With this background the differences related to variations in the conditions of exposure can usually be understood. The individual human or animal organism receiving the exposure must also be considered in the final outcome of the experience because age, sex, nutritional status and presence of pre-existing disease may be significant variables. (auth)

44895 RADIATION EFFECTS ON THE MYELOCYTIC CELL RENEWAL SYSTEM. Killmann, S.-Aa. (University Hospital, Copenhagen). pp 89-97 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Granulocytopenia is a component of the haemopoietic syndrome that results from exposure to high doses of penetrating ionizing whole-body irradiation. The resulting decreased resistance to bacterial infection is a significant factor in radiation morbidity and lethality. In this chapter a brief outline is presented of normal neutrophil granulocyte proliferation and kinetics and of the radiation-induced changes of granulocytes and their precursors in blood and bone marrow. Finally, an attempt to explain these changes in terms of a disturbance of the normal granulocyte renewal is made. (auth)

44896 EFFECTS OF RADIATION ON ERYTHROPOIESIS. Harriss, E. B. (Univ., Ulm, Ger.). pp99-107 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Effects of radiation in the circulating blood are discussed with regard to red cell function, anemia, and ^{59}Fe in circulating erythrocytes. Discussions are also given of the effects of 200 R doses on bone marrow cell counts, response of rats to mid-lethal or lethal doses of radiation, and measures modifying the erythropoietic response. Death from haemopoietic failure following a $LD_{50/30}$ dose of radiation is probably not attributable to failure of erythropoiesis; while damage to the erythropoietic system certainly plays a part in the syndrome, it is not a major factor contributing to the death of the animal. Although the severity and time course of the response vary with the species studied, the general effects of radiation on erythropoiesis are similar in all mammalian bone marrow studied to date. Likewise, though the severity of the reaction varies somewhat with the energy of the radiation and has been used to compare the relative biological effectiveness of different types of radiation, the response is different only in degree and not in its fundamental pattern. The initial syndrome of depression and recovery will therefore be described largely by reference to work performed on the response of the rat to single acute exposures of either whole-body or partial-body irradiation with conventional x-rays. (H.L.W.)

44897 RADIATION EFFECTS ON THE MEGAKARYOCYTE AND PLATELET SYSTEM. Odell, T. T. Jr. (Oak Ridge National Lab., Tenn.). pp 109-16 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A discussion is given of the general timing of radiation effects on megakaryocytes and platelets. Studies on rats included radiation effects on number of megakaryocytes and platelets and effects on morphologic compartments of megakaryocytes. Studies are reviewed on the effects of radiation on megakaryocytes and platelets in man, rabbits, and mice. The effects of radiation on the megakaryocyte and platelet system are of great importance after whole-body exposure in the sublethal to just supralethal dose ranges since damage to this system may give rise to the haemorrhagic syndrome. In brief, radiation brings about a depletion of the megakaryocytes of the haemopoietic tissue as part of a general hypoplasia or aplasia of this tissue in response to radiation and thereby removes the source of the platelets, whose function is to maintain the integrity of the walls (endothelium) of the vessels of the circulatory system, as well as to take part in the blood-clotting process. A combination of infection and blood loss is usually responsible for death in animals and men that succumb to the haemopoietic syndrome but animals in which infection has been successfully controlled with leukocyte transfusions or antibiotic therapy may still succumb to haemorrhage alone. (H.L.W.)

44898 RADIATION EFFECTS ON BLOOD COAGULATION. Sise, H. S. (Tufts Univ., Boston). pp 117-21 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Haemorrhage is an important and ominous sign in acute radiation disease. While it is overwhelmingly evident that thrombocytopenia is the major cause of the haemorrhagic diathesis, detailed observations of all of the changes in the coagulation mechanism, fibrinolytic elements and platelet function are lacking. The current knowledge is reviewed in this chapter. In general, changes should be considered in relation to the course of the disease, that is early or late, and whether the observations were made in man or animals. The various components of the coagulation and fibrinolytic systems will be taken up separately. (auth)

44899 HAEMATOLOGICAL EFFECTS OF CONTINUOUS RADIATION EXPOSURE. Blackett, N. M. (Royal Cancer Hospital, Belmont, Eng. Royal Marsden Hospital, Belmont, Eng.). pp 123-8 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The haematological effects arising from continuous irradiation have been studied over a wide range of dose rates using various types of radiation and several species of animals. Much of the experimental data on continuous irradiation is for low dose rates where only minor haematological changes occur and only after a considerable length of time and where, because of the appreciable natural fluctuation in peripheral blood count, it is difficult to demonstrate statistically significant changes in cell counts between one group of animals and another. The effect of continuous irradiation at high dose rates, where the changes can be determined with some certainty, will be considered first. The response at dose rates above 15 rad/d will be described for one strain of rat only in order to demonstrate how the response changes progressively from one that resembles acute lethal irradiation to one in which bone marrow failure no longer occurs and death is due to other causes. (auth)

44900 HAEMATOLOGICAL CONSEQUENCES OF RADIOISOTOPE INCORPORATION WITH PARTICULAR REFERENCE TO TRITIUM, PHOSPHORUS, AND STRONTIUM. Cleaver, J. E. (San Francisco Medical Center). pp 195-213 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

The biological effects produced by radioisotopes within the body show certain differences from those produced by ionizing radiation from external sources. These differences arise because of the uneven distribution of radioactivity within the body and the unique physical processes involved in radioactive decay. In view of the localized nature of radioisotope effects, the metabolic routes and the biological half-life are paramount in determining biological effects. Two aspects of biological effects of radioactive decay are discussed. One aspect is the emission of some form of radiation, either α or β particles or γ rays, which are characteristic of the particular nuclide undergoing decay. The other aspect includes all events associated with the atom that remain after the decay. The dosimetry of incorporated radioisotopes is discussed, and the importance of clearly defining the physical location of a radioisotope and the volume over which the emitted radiation deposits its energy is emphasized. Biological effects of tritium are discussed with regard to dosimetry, in vitro studies, and in vivo studies. Effects of transmutation of ^{32}P to ^{32}S on DNA of viruses and bacteria and studies on the use of ^{32}P in the treatment of polycythemia vera are reviewed. Biological effects of ^{90}Sr are reviewed with regard to dosimetry and in vivo studies. Bone marrow damage and leukemia induced by high doses of ^{90}Sr are discussed. (H.L.W.)

44901 ANAEMIA AND OTHER BLOOD DISEASES INDUCED BY RADIATION. Zedginidze, I. (Inst. of Haematology and Blood Transfusion, Tbilisi, USSR); Kozinets, G. pp 243-50 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A review of radioinduced anemia includes discussions of the effects of the atomic explosions on man in Hiroshima and Nagasaki and studies on erythropoiesis in experimental animals. A table is presented to show effects of x radiation on count and repopulation of erythrocytes of guinea pigs, rats, rabbits, and dogs. Experimental data and clinical observations on leukosis induced by ionizing radiation are discussed with regard to dose effects and effects of local and whole-body irradiation. Forms of leukosis induced by radioisotopes include reticulosis, hemocytoblastosis, and myeloleukosis. A review of the increased incidence of leukosis in medical personnel is presented with emphasis on dose effects. Factors influencing radioinduced leukosis in patients following diagnosis and therapy are discussed. (H.L.W.)

44902 EFFECTS OF PRENATAL X IRRADIATION ON DEVELOPMENT AND POSTNATAL VIABILITY OF INBRED AND HYBRID MICE. Nash, Donald J. (Colorado State Univ., Fort Collins). Contract AT(11-1)-107. Biol. Bull.; 140: No. 2, 230-41(Apr 1971).

Developmental malformations and effects on postnatal viability were measured in inbred and hybrid mice that were irradiated at different stages of embryological development. Three genetically differentiated inbred strains of mice, BALB, K, and S, and their six possible types of hybrids, including reciprocals, were used. The design for these studies was factorial. There were five levels of irradiation: 0, 20, 80, 160, and 320R; five embryological stages: untreated, $6\frac{1}{2}$, $10\frac{1}{2}$, $14\frac{1}{2}$, and $17\frac{1}{2}$ days of gestation; two sexes; and mice of nine different inheritance types. Pregnant females were exposed to single whole-body 250 pkv x rays on a specified day of gestation as timed from the appearance of a vaginal plug. Malformations were scored at birth and postnatal mortality was followed through 75 days of age. Morphological anomalies observable at birth were found only after irradiation at $10\frac{1}{2}$ days gestation. Anomalies were observed after doses of 80R or more. Neonatal mortality also was highest following irradiation at $10\frac{1}{2}$ days. The LD_{50} at birth was found to be between 80 and 160R. With a dose of 320R all progeny were stillborn. Following treatment with 160R at $10\frac{1}{2}$ days there was 64 percent abnormal and 100 percent stillborn progeny among the inbreds compared to 29 percent abnormal and 64 percent stillborn among the hybrids. Effects of prenatal irradiation on postnatal survival to 60 days were at a minimum after treatment at $6\frac{1}{2}$ days gestation, reached a maximum following irradiation at $10\frac{1}{2}$ days, and then declined at $14\frac{1}{2}$ or $17\frac{1}{2}$ days. No consistent patterns of survival differences between males and females and level of irradiation and embryological stage at the time of treatment were observed. Among the control or non-irradiated mice, inbred progeny suffered a higher mortality than the hybrids especially during the first few days after birth. In those treatments which produced a significant increase in postnatal mortality, inbred genotypes responded to a greater degree than did hybrid genotypes. (auth)

44903 DYNAMICS OF THE CHANGES IN THE ULTRASTRUCTURE OF A SYMPATHETIC NEURON, INDUCED BY 300 R OF X IRRADIATION. Ferents, A. I. (Sector of Molecular Biology and Genetics, Kiev). Radiobiologiya; 11: No. 1, 74-9(Jan-Feb 1971). (In Russian).

The work presents the results of an electron microscopic investigation of the influence of whole-body x irradiation at a dose of 300 R on the ultrastructure of the nerve cells of the upper cervical sympathetic ganglion of rabbits. A description of the disruptions of the ultrastructure of various cellular organelles in the dynamics of the development of the radiation response is presented, and the characteristics of the compensatory-recovery processes are also noted. (tr-auth)

44904 SPERM PRODUCTION OF DOGS DURING CHRONIC GAMMA IRRADIATION FOR TWO YEARS. Fedorova, N. L.; Markelov, B. A. Radiobiologiya; 11: No. 1, 120-3(Jan-Feb 1971). (In Russian).

Continuous chronic γ irradiation at rates of 25 and 75 rad/year for a period of two years did not produce any visible disturbances of sperm production in the experimental animals. The radiation influence at a rate of 150 rad/year reduced the absolute number of spermatozoa and their mobility, and also somewhat increased the number of atypical forms of cells. A radiation burden on the organism with a total dose of the order of 100 to 120 rad (at a rate of 0.4 rad/day) can be tentatively taken as the threshold dose for dogs. (tr-auth)

44905 BIOLOGICAL EFFECTS OF ^{244}Cm. Semenov, A. I. (Inst. of Biophysics, Moscow). Radiobiologiya; 11: No. 1, 134-7 (Jan-Feb 1971). (In Russian).

In experiments on rats with intravenous injection of curium-244 chloride, LD_{50} was established for various periods, and the average lifetime of the animals was determined at doses from 0.4 to 0.005 μCi/g. Data are cited on the influence of the doses used on the clinical state of the animals, the change in weight, and the response of the peripheral blood. (tr-auth)

44906 ELECTRON MICROSCOPIC INVESTIGATION OF THE DEVELOPMENT OF RADIATION SICKNESS AND THE RESTORATION OF THE ULTRASTRUCTURES OF THE SYMPATHETIC NEURON. Ferents, A. I. (Sector of Molecular Biology and Genetics, Kiev). Radiobiologiya; 11: No. 1, 147-51(Jan-Feb 1971). (In Russian).

An electron microscopic investigation was made of the dynamics of the change in the ultrastructure of nerve cells of the upper cervical sympathetic ganglion of rabbits as a function of the dose in the case of total irradiation of the animal with x rays. It was discovered that the postradiation changes in the organelles of the neurons of the ganglion are monotypic under the influence of doses of 1400, 800, and 300 R, but their depth, extent, rate of onset, and rate of development depend on the value of the dose. A normalization of the submicroscopic structure of the ganglionic nerve cells toward the end of the first month after irradiation at doses of 300 and 800 R is also noted, indicating the occurrence of compensatory-recovery processes within the cells, together with the dystrophic processes. (tr-auth)

44907 INFLUENCE OF IRRADIATION OF THE HEAD WITH X RAYS ON THE DELAYED RESPONSES OF PUPPIES. Partskhaladze, N. N. (Inst. of Physiology, Tbilisi, USSR). Radiobiologiya; 11: No. 1, 151-3(Jan-Feb 1971). (In Russian).

The investigation indicated that irradiation of the heads of puppies with x rays at a dose of 440 R produces a disturbance of the delayed responses only for a short period of time. Subsequent repeated irradiations up to a summary dose of about 8000 R do not cause any deterioration of the delayed responses. (tr-auth)

44908 HAPTOGLOBIN AND IRRADIATION IN MICE. Burger, M.; Knyszynski, Ahuva (Weizmann Inst. of Science, Rehovot, Israel). Radiat. Res.; 46: No. 3, 613-20(Jun 1971).

A single x irradiation of mice caused a rise in the haptoglobin level in the serum in mice, the level increased with increase in the amount of radiation, up to near lethal doses, at which the haptoglobin level diminished. The amount of haptoglobin in the serum was smaller with fractionated doses of irradiation than with single doses. Endotoxin, or a protein fraction of human serum which contains the alpha-2 macroglobulin, increased the level of haptoglobin in both irradiated and nonirradiated mice. (auth)

44909 CELL PYKNOSIS IN THE CEREBELLAR CORTEX OF INFANT RATS FOLLOWING LOW-LEVEL X-IRRADIATION. Altman, Joseph; Nicholson, Jean L. (Purdue Univ., Lafayette, Ind.). Radiat. Res.; 46: No. 3, 476-89(Jun 1971).

Rats (9 days old) were irradiated with 100 R x rays (skull only) and then allowed to survive for varying intervals, ranging from 10 min to 24 hrs. Mitotic activity, cell pyknosis, and phagocytosis were examined in the external granular layer of the cerebellar cortex with light and electron microscopy. Mitotic activity was reduced within 1 hr after irradiation, ceased altogether by the 3rd hr, and was resumed again by the 6th hr. Cell pyknosis became first evident morphologically by the 3rd hr. Several phases of imminent cell death were distinguished. The first sign was the darkening of the nucleus, and the condensation and peripheral displacement of nuclear chromatin, with or without cytoplasmic involvement. The total condensation and rounding up of the nucleus was the second phase. The disappearance of nuclear membrane, the coalescing of nucleus and cytoplasm and the rounding up of the entire cell signaled cell death. Astrocytic reactic reaction to tissue damage was evident by the 3rd hr, phagocytosis was first seen after 6 hrs. Two types of phagocytic cells were identified, one that resembled Bergmann astrocytes and another that was indistinguishable in appearance from the typical undifferentiated cells of the external granular layer. (auth)

44910 EFFECTS OF THE GERMFREE STATE ON THE RESPONSE OF MICE EXPOSED TO NEUTRON-GAMMA RADIATION. McLaughlin, Mary M.; Woodward, Kent T.; Stromberg, LaWayne R. (Walter Reed Army Medical Center, Washington, D. C.). Radiat. Res.; 46: No. 3, 519-32(Jun 1971).

The response of germfree and conventional mice was compared after exposure to a wide dose range of fission spectrum neutrons (300 to 50,000 rads). Acute radiation effects as measured by percentage survival and by survival time were different. Mice free of detectable bacteria were more resistant to neutron radiation than were conventional controls. Germfree mice had a higher threshold for the production of mortality, had a greater proportion of 30-day survivors, and had longer survival times after all of the radiation exposures. The median lethal dose (LD 50/30) for conventional mice was 328 rads; for germfree it was 414 rads, or 1.3 times

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higher. The relative resistance associated with the germfree state in mice exposed to neutrons was of the same magnitude as that already established for germfree mice exposed to x rays. After exposure to supralethal amounts of neutrons extending well into the range producing evidence of severe damage to the central nervous system, the median survival times of germfree mice were always greater than those of conventional controls. The absence of bacteria during the period following radiation stress as well as the difference in gastrointestinal cellular dynamics are offered as explanations for the different effects of equal doses of neutrons. (auth)

44911 INTESTINAL CRYPT SURVIVAL AND TOTAL AND PER CRYPT LEVELS OF PROLIFERATIVE CELLULARITY FOLLOWING IRRADIATION: SINGLE X-RAY EXPOSURES. Hagemann, Ronald F.; Sigdestad, Curtis P.; Lesher, S. (Allegheny General Hospital, Pittsburgh). Radiat. Res.; 46: No. 3, 533-46(Jun 1971).

A radiation survival curve for intestinal crypts in mice following whole-body x irradiation was obtained. It was characterized by a D_0 of 330 R and n of 10. Crypt survival was quantitatively similar for assays performed at 3 and 4 days following irradiation, although crypt size varied considerably during this interval. An as yet unexplained discrepancy existed between the crypt survival curve obtained experimentally and that predicted from crypt cell survival parameters and compartment size. Proliferative crypt cells appeared to constitute the intestinal stem cell compartment. Recovery in terms of cellularity occurred even following exposures as high as 1400 R. It seemed critical for 5 day survival of the animal that proliferative cellularity reached some requisite level by day 3 following exposure; later increases in cellularity were not reflected by increased 5 day survival. It appeared from this that crypt survival is an important feature with respect to 5-day survival of the irradiated animal. (auth)

44912 EFFECT OF TEMPERATURE AND RADIATION STRESSES ON THE SURVIVORSHIP OF ISOPODS: ARMADILLIDIUM VULGARE AND CYLISTICUS CONVEXUS. Reichle, David E.; Van Hook, Robert I. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 46: No. 3, 588-600(Jun 1971).

Gamma radiation affects many metabolic processes whose rates are temperature-dependent in poikilothermic organisms. Laboratory experiments were designed to test the effects of temperature, ^{60}Co radiation, and their interactions on the survival of isopods, Armadillidium vulgare and Cylisticus convexus. A central composite rotatable design with dose and temperature as independent variables was used to construct three-dimensional response surfaces described by quadratic polynomial equations. Temperature treatments ranged between 12.9 and 27.1°C; radiation doses were between 8.3 and 19.7 kilorads. The response surfaces (survivorship) varied with time, from 0 to 60 days, both within and between species. Both temperature and dose became significant ($P < 0.05$) in the equation for isopod survival during the 60-day observation period. However, temperature effects became significant 10 to 20 days later than those of radiation dose for both species. The LD_{50-30}'s for A. vulgare and C. convexus were not significantly different at 16.9 kilorads. (auth)

44913 SOME BLOOD COAGULATION PROBLEMS IN WORKERS EXPOSED TO SMALL DOSES OF IONIZING RADIATION. Kriklava, J.; Koskova, D. (Inst. of National Health in Uranium Industry, Pribram, Czech.). Vnitr. Lek.; 16: No. 6, 530-7(Jun 1970). (In Czech).

A comparative study was made of blood coagulation in workers in the uranium industry who were exposed to small doses of ionizing radiation for a long period of time. Two groups of workers were compared: group I was exposed to radiation for 2 years; group II was exposed to radiation for more than 10 years. They were compared with a control group of persons who had never worked professionally with ionizing radiation. By the Rumpell–Leede method no lesion of the vascular wall was found in exposed workers. There also was no change in coagulation time when examined by the Lee–White method and compared with the control group. There was a statistically significant decrease in blood platelet count in both exposed groups. Thromboelastograms showed no deviations from controls or from normal values given in the literature for the classical factors (r, k, ma, mE). Also the time interval needed for maximum thrombus solidity to form (t-ma) did not differ from the control group. It was concluded that these low radiation doses do not cause, without additional supporting factors, health damage in exposed individuals even after long-term exposure. Such irradiation does not damage the tissues that produce substances important for blood coagulation. (NSA of Czech)

44914 LEUKEMOGENESIS IN THE RAT: FURTHER OBSERVATIONS. Moloney, William Curry; Batata, Mohammed; King, Vincent (Children's Cancer Research Foundation, Boston. Harvard Medical School, Boston). J. Nat. Cancer Inst.; 46: No. 6, 1139-43(Jun 1971).

Studies are reported on the occurrence of leukemia in Wistar, W/Fu, and Fischer rats after whole-body x irradiation, administration of 3-methylcholanthrene (MCA), and splenectomy. MCA given to 1-month-old W/Fu rats increased the incidence of leukemia, whereas 250 R of x ray markedly reduced the number of leukemias in Fischer rats. In 50 splenectomized Fischer rats, 2 months old, no leukemias developed. Various aspects of primary leukemia in inbred rats suggested a viral etiology; however, to date, attempts at passage of leukemia in this species by cell-free material were unsuccessful. (auth)

44915 EFFECT OF RADIATION ON DEOXYRIBONUCLEOPROTEINS IN ANIMAL TISSUES. IV. CHANGES IN THE HISTONE COMPONENT OF DEOXYRIBONUCLEOPROTEIN ISOLATED FROM TISSUES OF IRRADIATED MICE AND OF DNP FRACTIONS AFTER INTERACTION WITH HEPARIN. Cejkova, Milena; Skalka, M.; Matyasova, Jitka (Inst. of Biophysics, Brno). Folia Biol. (Prague); 17: No. 3, 189-95(1971).

Changes in the histone component of deoxyribonucleoprotein (DNP) in lymphatic tissues were analyzed, in order to elucidate the mechanism of the effect of radiation on DNP. It was found that the DNP, isolated from the thymus and spleen of irradiated mice (6 hours after whole-body exposure to 600R), contained a comparatively lower amount of histones. During the action of heparin on DNP suspension, proteins are released into the solution together with DNA. DNP isolated from tissues of irradiated animals was found to be several times more sensitive to heparin action than that separated from non-irradiated tissues. An incubation of DNP from irradiated tissues with an excess of histone reverted its increased sensitivity to heparin action back almost to the initial level of the sensitivity of non-irradiated DNP. After irradiation, a shift in the relative content of individual fractions of histones (separated by carboxymethylcellulose chromatography) in the DNP increased the proportion of the F_3 fraction. Similarly, a relatively higher proportion of the F_3 fraction of histone was found in the part of the DNP from irradiated tissues that had become soluble by the action of heparin. The relative loss of the F_1 and F_2 histone fractions is probably the cause of the increased heparin sensitivity of DNP isolated from irradiated tissues. (auth)

44916 ROLE OF A CANCEROGENIC CHEMICAL SUBSTANCE AND IONIZING RADIATION IN THE DEVELOPMENT OF NEOPLASMS. Zapol'skaya, N. A.; Fedorova, A. V.; Lavrent'ev, L. N.; Borovikova, N. M. Gig. Sanit.; No. 1, 55-9(Jan 1971). (In Russian).

The preliminary administration for a period of 6 months of strontium-90 in a dose of 4×10^{-3} and 4×10^{-2} μCi increased the incidence of tumors induced by a carcinogenic chemical substance. The administration to rats of a nonseparated mixture of isotopes, that, by the end of the year, was responsible for the accumulation in the skeleton of doses of 18, 180, and 540 rad, caused no development of osteosarcoma. In the joint action on the body of animals of both carcinogenic chemical substances and that of a mixture of isotopes at a concentration of 15 and 1.5 μCi the incidence of lymphoreticular sarcoma was much higher than in the action of the mixture of isotopes alone taken in the same amounts. (auth)

44917 RESPONSE OF THE PREOSTEOBLAST AND STEM CELL OF RAT BONE MARROW TO A LETHAL DOSE OF X-IRRADIATION OR CYCLOPHOSPHAMIDE. Amsel, Sheldon; Dell, Elisabeth S. (Boston Veterans Administration Hospital). Cell Tissue Kinet.; 4: No. 3, 255-61(May 1971).

Following syngeneic or autotransplantation of hemopoietic tissue to a heterotopic location, bone formation was observed to occur in the implanted tissue. The characteristics of the cell residing in hemopoietic tissue with bone forming potential (preosteoblast) are unknown. To define some properties of this cell, its response to x-irradiation and cyclophosphamide (CTX) was compared to the response of the hemopoietic stem cell. Adult, male rats were exposed to 900 R whole-body x irradiation or 220 mg/kg of intraperitoneal CTX. With either treatment the dose was sufficient to kill the animals by bone marrow failure. At intervals following the x irradiation or CTX, hemopoietic tissue was examined for the presence of viable hemopoietic stem cells and preosteoblasts. Following x irradiation, viable hemopoietic stem cells and preosteoblasts could not be detected. Following CTX these cells could be detected. It is suggested that in the rat CTX at 220 mg/kg, although causing death by bone marrow failure, does not reduce the population of the preosteoblast or hemopoietic stem cell as effectively as 900 R x-irradiation. (auth)

44918 REGENERATING RAT LIVER: A GOOD SYSTEM FOR RADIOBIOLOGICAL STUDIES. Pizzarello, Donald J.; Witcofski, Richard L. (New York Univ., N. Y. Bowman Gray School of Medicine, Winston-Salem, N. C.). Radiology; 100: No. 1, 163-7 (Jul 1971).

After partial hepatectomy, regeneration of Charles River male albino rat liver provided large numbers of nearly synchronously dividing cells. There was such variability in levels of DNA synthesis and mitosis among untreated hepatectomized animals, however, that demonstration of treatment effects was difficult. Mitosis was more radiosensitive than DNA synthesis and was completely inhibited after 500 rads during the early phases of maximum mitotic activity, which made variability among control animals less important. A dose of 250 rads did not completely inhibit mitosis. (auth)

44919 GENETIC EFFECTS OF ^{90}Sr ON VARIOUS STAGES OF SPERMATOGENESIS IN MICE. Forelen, H. (Forsvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 596-608(1970).

Inbred male CBA mice were injected with ^{90}Sr or ^{45}Ca and then mated, each male with three untreated females per week during five consecutive weeks. Most of the males were later used for another mating period during the 10th to 15th week post injection. More than 89,000 fetuses in the ^{90}Sr and ^{45}Ca series and about 58,500 in the controls were analyzed. The findings are considered in detail and their significance is discussed. (auth) (Sweden)

44920 EFFECT OF PROTRACTED ADMINISTRATION OF IRRADIATED FOOD ON RABBITS: HAEMATIC CONTROL ON PERIPHERAL BLOOD. Lai, P.; Pasqualini, C. (Univ., Sassari, Italy). Arch. Vet. Ital.; 22: No. 1, 3-9(28 Feb 1971). (In Italian).

A group of rabbits was fed irradiated food for one year to study any effect of such feeding on blood cells. The blood picture of experimental animals compared to the controls gave the following results: decrease of lymphocytes in peripheral blood; appearance of anisocytosis and of a great number of erythroblasts in peripheral blood; presence of cells very similar to immature elements of lymphoid series, usually absent in the blood of normal subjects; and presence of binucleated lymphocytes in peripheral blood. (auth)

44921 REACTION OF PROLIFERATING CARTILAGINOUS TISSUE TO 14.4 MeV-ELECTRONS, ^{60}Co-GAMMA- AND 200 kV X-RAYS. Stender, Hans Stephan; Hagemann, Gerd (Medizinische Hochschule, Hanover). Strahlentherapie; 141: No. 5, 573-80(May 1971). (In German).

The population kinetics of cartilage cells of the rat tail during the period of growth was used to measure the number of cells that were damaged through irradiation. Three cytologically known kinds of damage served as criteria for the radiation effect. Following irradiation with 200 kV x rays, ^{60}Co gamma rays, and 14.4-MeV electrons, graphic curves with relative maxima resulted for the portion of cells with reversible and postmitotic lethal damage; for the part with interphasic lethal effect threshold doses and linear dose dependence were found in the range up to 3000 rad. The importance of these results for the concept of RBE, for the newer theories of the biological radiation effect, and for the radiotherapeutically important terms fractionation and electivity is emphasized. (aut

44922 INVESTIGATION IN THE METABOLISM OF THE ISOLATED, PERFUSED HEART OF GUINEA PIG UNDER IRRADIATION. Buchelt, L.; Loehr, E. (Univ., Marburg, Ger. Ruhr Univ., Essen). Strahlentherapie; 141: No. 5, 604-11(May 1971). (In German).

On the isolated, perfused MS-heart by Langendorff the behavior of the energy possessing phosphates was investigated, following a single irradiation with high dose; the influence of the cardio-active drugs, oxyfedrine and g-strophantin, on the distribution of metabolites was tested. CP and ATP showed a significant increase as early as 20 minutes following irradiation accompanied by a corresponding decrease of AMP. After 60 minutes these changes equalized again, only ATP remained augmented for a longer time. It has not yet been decided if the mechanism works in the way of a metabolic activation or by decrease of energy utilization, like in a utilization insufficiency. These metabolic processes are enhanced by oxyfedrine and inhibited by g-strophantin. The possibility of a change in the membrane permeability for potassium, sodium, and calcium as a causal radiation effect is pointed out. (auth)

44923 RELATIONS BETWEEN SPLEEN AND HEMOPOIESIS. AN EXPERIMENTAL STUDY. Fresen, Otto; Kretschmer, Harald (Pathologisches Institut, Hanover). Z. Gesam. Exp. Med.; 154: 36-59(1971). (In German).

The hormonal actions of the spleen are discussed. The influence of spleen on hematopoiesis was investigated in guinea pigs by splenectomy and/or irradiation (550 R) alone or combined either preceding or following at intervals of 1, 7, or 14 days involving hematological and histological analyses. The healthy spleen exerted a controlling influence on overall hematopoiesis; this influence was demonstrable by the excessive activation of the bone marrow following splenectomy. Even the irradiated and thus functionally restricted spleen continued to exert an effect on the strongly regenerative phase of hematopoiesis insofar as the marrow damaged by irradiation will display a more rapid quantitative and qualitative recovery after removal of the spleen. It would appear that splenic extirpation also produced a certain degree of loosening of the physiological marrow-blood barrier with respect to immature blood cells in a regenerative marrow: this cannot be explained by any residual radiation effect, for in animals only irradiated either extramedullary immature precursors or aberrant hematopoiesis were present. (auth)

44924 LOW TEMPERATURE PRESERVATION OF MONKEY MARROW IN DIMETHYL SULFOXIDE. Buckner, C. Dean; Storb, Rainer; Dillingham, Lloyd A.; Thomas, E. Donnall (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). Cryobiology; 7: No. 2-3, 136-40(Sep-Oct 1970).

The marrow-repopulating ability of autologous marrow was evaluated in monkeys given 1200 R whole-body γ irradiation. Four monkeys given supportive therapy and no marrow infusion died within 13 days of irradiation with marrow aplasia. Six monkeys given marrow stored at 4°C for 4 hrs showed hematopoietic recovery and four lived beyond 60 days. Twenty monkeys receiving marrow stored at –80°C or –170°C in 10% dimethyl sulfoxide (DMSO) for 6 to 36 days showed histological evidence of marrow repopulation. Fourteen of the 20 showed recovery of white blood cell and platelet counts and eight survived beyond 60 days. It was concluded that 10% DMSO is a useful cryopreservative agent for monkey marrow. (auth)

44925 X-RAY AND TEMPERATURE: COMBINED EFFECTS ON MORTALITY AND GROWTH OF SALMON EMBRYOS. Wadley, Gerald W.; Welander, Arthur D. (Univ. of Washington, Seattle). Contract AT(45-1)-2255. Trans. Amer. Fish. Soc.; 100: No. 2, 267-75(Apr 1971).

Four embryonic stages of chinook embryos were irradiated with graded, acute doses of x rays (15 to 1530 R), in duplicate experiments, one at ambient temperature, the other at 2°C above ambient. The effects of temperature, irradiation, and handling were evaluated in terms of growth and mortality. Growth stimulation attributable to low dose irradiation was observed at both temperatures but was more apparent at the ambient temperature. (auth)

44926 HEMORRHAGIC SYNDROME IN THE IRRADIATION DISEASE. I. EXPERIMENTAL STUDY OF COAGULATION ALTERATIONS AND FIBRINOLYSIS IN RATS EXPOSED TO LETHAL X-RAY DOSES. Cutcudache, Caliopi; Voronca, Gabriela; Gorun, Vera; (and others). Fiziol. Norm. Patol. (Bucharest); 14: No. 4, 351-62(Jul-Aug 1968). (In Rumanian).

Blood fibrinolysis and clotting alterations were followed up in rats irradiated with a total dose of 700 R, 2, 5, 10, and 15 days after x-irradiation, and in a group of normal controls. The results showed a tendency to hypocoagulability, due to severe thrombocytopenia, the deficient utilization of prothrombin, increase in the heparin cofactor and antithrombin III, decrease in proaccelerin, and a tendency to an increase in the activity of the fibrinolytic activators. The possible pathogeny of these changes and different interpretations are discussed. These biologic alterations are accompanied by a hemorrhagic syndrome. (auth)

44927 CHARACTERISTICS OF THE ESTROUS CYCLE AFTER X IRRADIATION OF THE DIENCEPHALON REGION IN FEMALE RATS. Lyubenov, I.; Lalova, M. (Medical Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv); 12: No. 1, 75-80(1970).

Studies were made on the effect of x radiation on the estrous cycle of female white rats. After checking the normal estrous cycle of 22 four-month old rats, they were given a dose of 800 R in the region of the mid-brain. During the next 49 days vaginal smears were periodically taken and examined, and at the end of this period a histological examination of ovaries, uterus, and tubes was made. Function disturbances and morphological changes of these organs were observed, along with a pathological aberration in the characteristics of the estrous cycle as a result of decreased sex gland activity. (K.S.W.)

44928 STUDIES ON THE RELATIONSHIP BETWEEN THYMUS REGENERATION AND LYMPHOMA PREVENTION IN C57Bl/6 MICE IRRADIATED AND INJECTED WITH SYN-

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GENEIC SPLEEN CELLS. Chen, Louise (Weizmann Inst. of Science, Rehovoth, Israel). Int. J. Cancer; 7: 491-8(1971).

Adult syngeneic spleen cells, that protect against radiogenic lymphoma, failed to induce thymus recovery after x irradiation. Bone-marrow cells that afford the same protection against lymphoma induction were effective in promoting thymus regeneration. Similar observations were made in the experiments on incorporation of ^{3}H-thymidine and ^{14}C-phenyl alanine into thymuses of mice irradiated and injected with spleen or bone marrow cells. It appears that there are two different factors by which hematopoietic cells independently promote thymus regeneration and prevent lymphoma induction. (auth)

44929 PATHOLOGIC EFFECTS ON DIFFERENT DOSES OF RADIOSTRONTIUM IN MICE. CHANGES IN THE HAEMATOPOIETIC SYSTEM. Nilsson, Agnar (Forsvarets Forskningsanstalt, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 528-44(1970).

The quantitative and qualitative effects of various doses of ^{90}Sr on the hematopoietic system in four groups of CBA male mice and in controls are described. (auth) (Sweden)

44930 ULTRASTRUCTURAL CHANGES IN THE RABBIT HEART FOLLOWING HIGH-DOSED ^{60}Co WHOLE-BODY EXPOSURE OF SHORT DURATION. Moellmann, H.; Decker, S.; Alfes, H.; Reisch, J. (Westfaelische Wilhelms-Univ., Muenster, Ger.). Strahlentherapie; 141: No. 4, 451-6(Apr 1971). (In German).

Light- and electron-microscopical findings showed that under the influence of high-dose whole-body γ radiation early changes of the myocardium occur. The examined material originated from 24 domestic rabbits, weighing approximately 2 kg each. The radiation dose amounted to 30,000 rad, exposure time was 45 to 50 minutes, and survival time post irradiation up to 2 hours. In the light microscope, a dissociation of heart muscle cells and a round-cell infiltration in the interstitial connective tissue were observed, and after a survival time of 2 hours also small band-shaped necroses. The ultrastructural analysis showed the most striking alterations on the mitochondria and on the EPR of the heart muscle cells. In the vessels, myofibrils, and disci intercalares no perceptible morphological damages were observed. The above described early changes increased in the course of the observation period. (auth)

44931 ROLE OF MICROENVIRONMENTAL FACTORS IN HEMATOLOGIC RESPONSE OF MICE EXPOSED TO 1000 R SPLIT-DOSE IRRADIATION AND TESTOSTERON TREATMENT. Hajdukovic, Srdjan (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie; 141: No. 4, 464-71(Apr 1971).

$C_{57}B1$ mice exposed to a conditioning dose of 400 TBR and immediately afterwards to local irradiation of the exteriorized spleen and one hind leg with 600 R x rays, were used for the study of testosterone effects on hematologic regeneration. One group of mice received testosterone (2.5 mg/mouse) immediately after the conditioning dose, 24 hours, and the third and fifth day post radiation; the second group received testosterone 24 hours and the third and fifth day post radiation. Decrease of splenic weight index, cell count/mg of spleen, spleen colony number, and ^{59}Fe incorporation was found during the first post radiation week in whole-body as well as split-dose irradiated testosteron-treated mice. This decrease was more evident in mice receiving testosterone immediately after irradiation. Regeneration of spleen occurred during the second post radiation week, being more stimulated in testosterone-treated mice if applied immediately after irradiation than applied 24 hours later. The number of spleen colonies decreased significantly in testosterone-treated mice in spite of stimulated spleen regeneration indicating that mechanisms other than the formation of spleen colonies are involved. Bone marrow in split-dose irradiated mice with testosterone treatment showed the onset of erythroid regeneration already on the eighth day post radiation. Aplastic marrow was found in control mice up to the tenth day post radiation. The results suggested that CFU is not the only mechanism by which the repopulation of radiation-depleted hematopoietic organs occurred. The microenvironmental factors play an important role in the determination of hematopoietic regeneration after high doses of x rays. (auth)

44932 CHANGES OF ACTIVITY OF PROTEOLYTIC ENZYMES IN BLOOD AND URINE OF WHOLE-BODY X-IRRADIATED ANIMALS. Vranovska, J.; Pospisil, J.; Dienstbier, Z. (Charles Univ., Prague). Strahlentherapie; 141: No. 4, 472-7(Apr 1971).

In rats whole-body irradiated with 800 and 200 rad, and in dogs, irradiated with 600 rad, a decrease of activity of serum pepsin was found within the first 24 hours after irradiation. In rats that were whole-body irradiated with 800 and 200 rad, the lowest values were found after 24 hours, in dogs after three and six hours following whole-body irradiation. These findings were identical if the method of heteroproteolysis (substrate HSA ^{131}I) as well as the method of autoproteolysis was used. Within the first 24 hours after irradiation, a decrease of activity of serum cathepsins estimated at pH 3.8 and 6.0 was found in whole-body (800 and 200 rad) irradiated rats. In dogs, after whole-body irradiation with 600 rad, an increase of activity in these enzymes was observed. In urine of whole-body irradiated dogs (600 rad) a decrease of activity in uropepsin and cathepsins estimated at pH 3.8 was found within the first 24 hours. The activity of cathepsins at pH 6.0 was increased during this time interval. (auth)

44933 OCCURRENCE OF ECTOPIC THYROID IN THE NORMAL AND EXPERIMENTAL INDIAN PALM SQUIRREL FUNAMBULUS PENNANTI (WROUGHTON). Vijayan, E.; Sathyanesan, A. G. (Banaras Hindu Univ., India). Strahlentherapie; 141: No. 4, 485-90(Apr 1971).

Out of 150 normal F. pennanti examined, four had perithyroid follicles in the fat tissue. Histologically, they did not show any difference from those of the main thyroid. Out of 301 animals exposed to varying doses of ^{131}I ranging from 50 μCi to 1.5 mCi, two exhibited ectopic follicles. They were seen in the perithyroid connective tissue and in the parathyroid of specimens examined six months after 200 μCi treatment. While the main thyroids of the 200 μCi treated animals were in different states of degeneration, the ectopic follicles were normal and much larger than the controls. If these had been functional at the time of ^{131}I treatment, they would have shared the fate of the main thyroid. Therefore, these might have developed from the thyroid rests after partial degeneration of the main thyroid and the excretion of radioiodine. Thus, in this species some ectopic thyroid functions along with the main one, whereas other rests start functioning when the function of the main gland is impaired. (auth)

44934 EFFECT OF X IRRADIATION ON THE INDUCTION OF ANILINE HYDROXYLASE BY PHENOBARBITAL IN PARTIALLY HEPATECTOMIZED RATS. Hilton, John; Sartorelli, Alan C. (Yale Univ., New Haven). Biochim. Biophys. Acta; 237: No. 1, 107-11(Apr 1971).

DNA synthesis in regenerating rat liver was prevented by exposure of the animals to relatively low doses of x irradiation; similar irradiation of unoperated animals that received either saline or phenobarbital had no effect on either the basal level of aniline hydroxylase activity or the appearance of elevated enzymic activity 24 hr after phenobarbital. Sham operated rats treated with phenobarbital showed a two-fold increase in enzymic activity at 24 hr after the inducer. No increase in aniline hydroxylase activity occurred at this time in partially hepatectomized rats that received x irradiation either 20 min, 3 hr, or 6 hr after surgery. In contrast, aniline hydroxylase activity was normally elevated in animals exposed to x irradiation 1 hr after partial hepatectomy. (auth)

44935 INDUCIBLE ENZYMES AND IONIZING RADIATION. COMMUNICATION 2. THE CHANGES IN TYROSINE-α-KETOGLUTARATE AMINOTRANSFERASE AND N-DEMETHYLASE ACTIVITY IN THE RAT LIVER AFTER IRRADIATION. Popov, P. G. (Higher Military Medical Inst., Sofia). Radiobiologiya; 11: No. 2, 174-9(Mar-Apr 1971). (In Russian).

The change in the enzyme activity of tyrosine-α-ketoglutarate aminotransferase was investigated 4, 24, 48, and 72 hrs after irradiation at doses of 450, 900, 1,800, and 5,000 R. Irradiation induced an increase in the enzyme activity with maxima at 4 and 72 hrs, with a complete return to normal by 24 hrs. The dose versus effect dependence was exponential at 4 hrs and linear up to a dose of 1,800 R at 72 hrs, followed by a significant decrease at 5,000 R. Adrenalectomy removed both maxima, while actinomycin D and cycloheximide removed the first maximum. The cytostatic cyclophosphamide at a dose of 400 mg/kg reproduced the curve of enzyme activity observed after irradiation. The microsomal oxidizing enzyme pyramidone N-demethylase was distinguished by a slow and weaker increase after irradiation at 900 R. The induction of demethylase with phenobarbital proceeded without deviation for the irradiated animals in comparison with the norm. (tr-auth)

44936 CHANGE IN THE LOCALIZATION OF HISTONES IN THE THYMUS AND LIVER OF IRRADIATED RATS. Korol, B. A.; Kuzin, A. M.; Minaev, P. F.; Medvedeva, I. F.; Khokhlova, G. K. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya; 11: No. 2, 180-4(Mar-Apr 1971). (In Russian).

The effects of γ irradiation on the degree of dissociation of the nucleohistone complex of rat thymus and liver nuclei were investigated. It was found that irradiation of the animals at doses of 400,

1,000, and 5,000 R leads to labilization and subsequent isolation of the histones from DNP. A pronounced loss of histones by the nuclei of the rat thymus and liver, developing with time, was observed. The amino acid composition of the "free" histones and their electrophoretic characteristics in polyacrylamide gel were also investigated. (tr-auth)

44937 INFLUENCE OF CORTISOL AND ADRENALIN ON THE CARBOHYDRATE METABOLISM OF THE BRAIN OF ADRENALECTAMIZED RATS SUBJECTED TO NEUTRON IRRADIATION. Mironova, T. M.; Cherkasova, L. S.; Fomichenko, V. G. (Inst. of Physiology, Minsk). Radiobiologiya; 11: No. 2, 185-9(Mar-Apr 1971). (In Russian).

The effects of cortisol and adrenalin on the content of the bound and free fractions of glycogen, G-1-P, and G-6-P in the brains of adrenalectomized rats after irradiation with intermediate-energy neutrons at a dose of 13.5 rad were studied. Irradiation was accompanied by a normalization of the glycogen-protein complex, and an accumulation of "free" glycogen, G-1-P, and G-6-P in adrenalectomized rats receiving both hormones in comparison with irradiated intact or adrenalectomized animals. Lipid-bound glycogen proved to be inert to the action of hormones. The general polysaccharide level remained within normal limits. (tr-auth)

44938 STUDY OF THE RECOVERY OF CRITICAL SYSTEMS OF THE MAMMALIAN ORGANISM, DETERMINING VARIOUS FORMS OF RADIATION DEATH. Kovalev, V. P.; Plotnikova, E. D.; Eidus, L. Kh. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya; 11: No. 2, 195-200(Mar-Apr 1971). (In Russian).

The dynamics of the recovery of F_1(CBA × C57BL) mice after γ irradiation at doses of 350 and 500 R were studied by the method of two irradiations according to the survival criterion $LD_{50/3-7}$ and $LD_{50/8-20}$. This permitted a refinement of the parameters of recovery that characterize the hematogenic system. Information on the rates of recovery of the gastrointestinal tract was obtained, and a definite conclusion on the contribution of recovery processes to the radiation response of mammals from a comparison of these data was formed. The quantitative characteristics of recovery obtained according to the criterion of survival of the animals in the case of the hematogenic form of death were compared with the corresponding parameters of the pool of stem cells of the hematogenic and gastrointestinal systems. (tr-auth)

44939 CYTOPLASMIC BUDDING OF LYMPHOID CELLS (CLASMATOSIS) AND HEMATOGENESIS IN IRRADIATED RATS. Kabakov, E. N. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 11: No. 2, 201-6(Mar-Apr 1971). (In Russian).

Whole-body γ irradiation at doses of 200, 400, and 600 R induced at first a decrease in the absolute content of cytoplasmic fragments in the spleens of Wistar rats, and then an increase in their amount, which exhibited an inverse dependence on the dose of irradiation on the 12th day and was correlated with the absolute content of lymphocytes in the bone marrow of the tibia. The similarity of the kinetics of the change in the relative content of cytoplasmic fragments in the spleen, cervical lymph nodes, and thymus at doses of 400 and 600 R was interpreted as a manifestation of a systemic response of the entire lymphoid tissue to total irradiation. (tr-auth)

44940 INFLUENCE OF BACTERIAL POLYSACCHARIDES ON HEMOPOIESIS IN THE CASE OF THEIR ADMINISTRATION AFTER IRRADIATION. Dikovenko, E. A.; Elistratova, Zh. V. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya; 11: No. 2, 207-11(Mar-Apr 1971). (In Russian).

It was found in experiments on noninbred mice, irradiated with γ rays at LD_{60-70}, that the polysaccharides isolated from typhoid fever bacteria or plague bacillus, as well as corpuscular vaccine from paratyphus bacteria, when administered in the first hours after irradiation, had a stimulating influence on the restoration of hematopoiesis. The use of these agents 30 to 60 min after irradiation was the most effective. Pyrogenal had no effect. In experiments on BALB/c mice, the influence of polysaccharides on hematopoiesis was weaker than in noninbred mice. The possible causes of the ineffectiveness of the postradiation use of bacterial agents are discussed. (tr-auth)

44941 CHARACTERIZATION OF THE COMPARATIVE RADIOSENSIVITY OF RATS OF THE AUGUST AND WISTAR LINES. Pauper, A. I. (First Moscow Medical Inst.). Radiobiologiya; 11: No. 2, 217-20(Mar-Apr 1971). (In Russian).

The radiosensitivity of August and Wistar line rats was studied. With respect to all the indexes used, the August rats were more sensitive to the action of penetrating radiation. On the basis of an analysis of the literature and the results of the experiments conducted, it was hypothesized that the genetic apparatus is more sensitive in animals of the August line in comparison with noninbred rats and Wistar rats, and the August rats are more reactive with respect to various influences. (tr-auth)

44942 SIGNIFICANCE OF THE TOXIC EFFECTS OF AN IRRADIATED MEDIUM IN THE POSTRADIATION DEATH OF CELLS. COMMUNICATION I. EXPERIMENTS ON AMOEBA PROTEUS. Bychkovskaya, I. B.; Ochinskaya, G. K.; Ryumtseva, A. I. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya; 11: No. 2, 235-8(Mar-Apr 1971). (In Russian).

In experiments on amebas, observed in individual lines, it was found that the dependence of the average lifetime on the value of the radiation dose is exponential. It was established that in the range of x-ray doses 0.5 to 40 kR, at doses of 80, 100, and 120 kR, and in the dose range 150 to 400 kR, the mechanisms of amebic death are quite different. It was determined that the toxic products formed in the irradiated medium play different roles in different forms of injury of the amebas. Whereas the influence of the irradiated medium was negligible in the case of large doses of radiation (80 kR and above), the long-term inactivation of the amebas at lower doses (0.5 to 40 kR) that occurred after repeated divisions (up to 28 cycles), was apparently entirely associated with toxic factors. (tr-auth)

44943 ROLE OF THE INTERNAL MEDIUM OF THE BRAIN IN THE MECHANISM OF PROTECTIVE RESPONSES DURING IRRADIATION. Kuzovkov, A. G.; Mozzhukhin, A. S.; Petelina, V. V. (Military Medical Academy, Moscow. Inst. of Experimental Medicine, Leningrad). Radiobiologiya; 11: No. 2, 239-44 (Mar-Apr 1971). (In Russian).

An analysis of the changes in the electrolyte composition and the components of acid-base equilibrium after total x irradiation and stimulation of the protective zone of the hypothalamus indicated that the general complex of protective responses of the organism during acute radiation sickness includes a maintenance of dynamic equilibrium of the internal medium of the brain. This is accomplished by the nervous system, in particular, the protective zone of the hypothalamus, by a change in the active function of the blood-brain barrier. (tr-auth)

44944 RELATIVE BIOLOGICAL EFFECTIVENESS OF ACCELERATED PROTONS IN VARIOUS PORTIONS OF THE BRAGG CURVE. Vainson, A. A.; Lomanov, M. F.; Shmakova, N. L.; Blokhin, S. I.; Yarmonenko, S. P. (Inst. of Experimental and Clinical Oncology, Moscow. Inst. of Theoretical and Experimental Physics, Moscow). Radiobiologiya; 11: No. 2, 258-64 (Mar-Apr 1971). (In Russian).

The RBE of protons in various points of the Bragg curve was determined on the medico-biological tract of the synchrotron of the Institute of Theoretical and Experimental Physics, in comparison with γ irradiation by ^{137}Cs. The RBE of protons with an energy of 90 MeV, according to the survival of HeLa and Chinese hamster cells was equal to 0.75 and 0.68, respectively, while according to the formation of chromosome aberrations, it was 0.77. The RBE of protons in the Bragg peak (average proton energy 8 MeV), in comparison with the plateau, was 1.44 ± 0.08 times higher with respect to the survival of the hamster cells and 1.85 ± 0.15 times higher with respect to aberrations. The method of measuring the absorbed dose in various portions of the Bragg curve with the aid of an ionization chamber is outlined. Experiments conducted to refine the value of the coefficient of conversion of the exposure dose to the absorbed dose in the case of γ irradiation of cells at the glass-air boundary are described. (tr-auth)

44945 STUDY OF THE ALDOLASE ACIDITY IN THE SUBCELLULAR FRACTIONS OF THE RAT LIVER IN THE CASE OF TOTAL X IRRADIATION. Musiiko, V. A.; Solynina, A. G. (Odessa Medical Inst.). Radiobiologiya; 11: No. 2, 265-8(Mar-Apr 1971). (In Russian).

The aldolase activity in a homogenate, nuclei, mitochondria, and supernatant liquid of the rat liver was investigated 1 hr and 1, 3, 10, and 30 days after total irradiation at a dose of 600 R. The method of differential centrifuging was used to isolate the cellular structures. The maximum changes in the enzyme activity were observed in the mitochondria and nuclei. (tr-auth)

44946 COMPARATIVE INVESTIGATION OF THE ACTION OF RADIOTOXINS AND GAMMA RAYS ON THE TRANSPORT OF IONS IN SLICES OF THE RAT KIDNEY CORTEX. Kasymov, A.; Omarov, K. N. (Tashkent State Univ.). Radiobiologiya; 11: No. 2, 269-71(Mar-Apr 1971). (In Russian).

XUM

The change in the ionic composition within the cell under the influence of radiation and radiotoxins isolated from irradiated potato tubers, as a function of the dose of irradiation and the concentration of radiotoxins, was demonstrated. (tr-auth)

44947 DISTURBANCE OF THE EXCRETION OF RIBOFLAVIN AND ASCORBIC ACID IN RADIATION SICKNESS AGAINST A BACKGROUND OF QUALITATIVELY DIFFERENT PROTEIN NUTRITION. Egorova, N. D.; Perepelkin, S. R. (First Moscow Medical Inst.). Radiobiologiya; 11: No. 2, 271-4(Mar-Apr 1971). (In Russian).

The excretion of riboflavin and ascorbic acid during radiation sickness in rats fed varying diets, such as physiological, meat, milk-egg, and vivarium, was studied. All the diets contained the same, normal amount of protein. In the first three diets there was an optimum, and in the vivarium diet a reduced amount of proteins of animal origin, differing in quality. The milk-egg diet, containing the proteins of milk and eggs, and to a comparatively small degree the physiological and vivarium diets, including milk proteins, had a normalizing influence on the excretion of the indicated vitamins from the organism. The meat diet, containing meat proteins, had a negative effect. (tr-auth)

Man

Refer also to abstracts 44802, 44803, 44806, 44808, 44809, and 44841–44844

44948 (STI/DOC-10/123) MANUAL ON RADIATION HAEMATOLOGY. Technical Reports Series No. 123. (International Atomic Energy Agency, Vienna (Austria)). 1971. 442p. IAEA $11.00.

Separate abstracts were prepared for 31 chapters of the manual. Two additional chapters are included on conservation of blood and bone marrow cells for clinical use and hematological control under normal conditions. (H.L.W.)

For abstracts of individual chapters see: 44754, 44778–44780, 44804–44809, 44841–44844, 44881, 44882, 44893–44901, and 44949–44954.

44949 RADIATION ENVIRONMENT OF HUMAN BEINGS. Schmier, H. (Wissenschaftlicher Direktor im Bundesgesundheitsamt, Berlin); Seelentag, W.; Waldeskog, B. pp 7-30 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A discussion is presented of radiation effects on man with regard to somatic-stochastic effects, genetic effects, and effects of low radiation doses. The following aspects of cosmic radiation are discussed: primary cosmic radiation, Van Allen belts, secondary cosmic radiation, and tissue dose through cosmic radiation. Terrestrial radiation is discussed with regard to terrestrial radiation outdoors, terrestrial radiation inside buildings, and exposure of the respiratory tract through radon. Effects of natural background radiation on man in excess of cosmic and terrestrial radiation are discussed with emphasis on natural radionuclides such as ^{40}K, ^{14}C, and ^{3}H incorporated into the body. The correlation between radioactive content of radionuclides in man and those in water and foodstuffs is represented by a table giving data for ^{226}Ra. Man-made radiation exposure is discussed with regard to radioactive fallout; radiation exposure of occupationally exposed persons; radioactive luminous dials, shoe-fitting fluoroscopes and television sets; and exposure of patients through medical uses of radiation. (H.L.W.)

44950 RADIATION EFFECTS ON THE LYMPHOCYTIC CELL RENEWAL SYSTEM. Kozinets, G. (Central Inst. of Haematology and Blood Transfusion, Moscow). pp 129-33 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A discussion is presented of the embryonic development of lymphatic tissue in mammals. The production, circulation, and properties of lymphocytes are reviewed and the advantage of using labeled precursors in these studies is pointed out. A review of radiation effects on lymphocytes includes discussions of morphological changes in lymphocytes in persons working with cyclotrons; radioinduced lymphocytopenia in calves following extracorporeal radiation of blood; effects of radiation dose on count of lymphocytes of rats; studies on radiosensitivity of lymphocytes as a function of their age using tritiated thymidine; radioresistance of lymphocytes in patients with lymphocytic leukemia; effects of protons on lymphocytes of monkeys and rats; comparative effects of protons and gamma radiation on lymphocytes of rats; and studies on lymphocyte counts of personnel working with radioactive materials at various institutes of the USSR Academy of Sciences. (H.L.W.)

44951 CLINICAL ASPECTS OF CHRONIC RADIATION INJURY. Betz, E. H. (Univ., Liege); Cottier, H.; Nakao, K.; Odartchenko, N. pp 175-9 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

A review of radioinduced leukemogenesis in man and mice is presented. It is pointed out that the two main factors influencing the leukemogenic effect of radiation are the age of the animals at the time of exposure and the dose of radiation. Results of studies on thymic and myeloid leukemia in mice suggested that the amount of radiation needed to increase the incidence of myeloid leukemia was less than that required to increase the frequency of thymic lymphomas. Radioinduced leukemia in man is discussed with regard to the following topics: high incidence of leukemia among atomic bomb survivors; leukemia among children receiving intrauterine irradiation; leukemia among radiologists; leukemia occurring in patients with ankylosing spondylitis treated with x radiation; and incidence of leukemia in children irradiated for thymic enlargement. Radioinduced neoplasms other than leukemia are briefly discussed. (H.L.W.)

44952 LATE EFFECTS ON HAEMOPOIESIS AND LIFE-SHORTENING. Betz, E. H. (Univ., Liege); Cottier, H.; Nakao, K.; Odartchenko, N. pp 181-90 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Experimental results of late effects produced by single, fractionated, and chronic irradiation in mice and rats are described with regard to peripheral blood counts and histopathology of bone marrow. Late effects on blood counts and bone marrow of human survivors of the atomic bombing in Japan are discussed and chromosome aberrations in men accidentally exposed to whole-body radiation from fast neutrons and gamma rays are described. Studies on radioinduced shortening of life span in experimental animals and man are reviewed and possible mechanisms underlying radioinduced life shortening are discussed. (H.L.W.)

44953 SPECIAL PROBLEMS OF PARTIAL-BODY EXPOSURE. Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). pp 191-3 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Homogeneous whole-body exposure can be accomplished only in small laboratory animals and it must be admitted that the dose is always unevenly distributed when large animals or human beings are submitted to ionizing radiation. In most cases it is not the damage to the haemopoietic system that is critical, but nevertheless it can limit the therapeutic possibilities and it is therefore important to evaluate the degree of impairment of the haematopoietic functions. Knowledge in this field is unfortunately limited, but this chapter will provide some recent experimental information and report the observations made on some human cases of incidental overexposure. It is, however, necessary to keep in mind that in all types of radiation exposure it is important to distinguish between those biological effects that indicate total dose regardless of what proportion of the body or what anatomical region has been exposed, and those that may be taken as a reflection of the total injurious effect of exposure. (auth)

44954 DIFFERENTIAL DIAGNOSIS OF RADIATION INJURY. Wendt, F. (Evangelisches Krankenhaus, Essen-Werden, Ger.). pp 297-301 of Manual on Radiation Haematology. Vienna; International Atomic Energy Agency (1971).
See STI/DOC-10/123.

Hematological changes in bone marrow and changes in blood cell values are reviewed in relation to radioinduced changes. A discussion is presented of the differential diagnosis of the hematological alteration following radiation exposure with regard to numerical alterations and morphological abnormalities in blood cells and bone marrow. Differential diagnosis of radiation damage requires intensive investigation concerning the radiation dose and time course of the alterations appearing in blood cells and bone marrow. There is no haematological method so far available that can specifically answer the question whether or not a certain haematological alteration is radiation-induced as every single abnormality of blood cells and marrow can be seen in a variety of other conditions. However, if there has been evidence of radiation exposure, then cytological abnormalities occurring during certain phases after exposure can be used to confirm the diagnosis and in estimating the probable course. The most sensitive method so far available seems to be the investigation of chromosomal abnormalities in stimulated blood lymphocytes which indicate a latent subclinical radiation effect and provide the information on which individual prognosis may be made. (H.L.W.)

44955 CHANGES IN THE REACTIVITY OF THE CHILDREN ORGANISM AFTER IRRADIATION OF NASOPHARYNX. Jansa, P.; Kucera, M.; Zemanek, R. Cesk. Radiol.; 24: No. 5, 202-7(1970). (In Czech).

A sample of children with irradiated nasopharynx up to the total dose of 300 R was repeatedly examined simultaneously with a control group. The process of cellularization of artificial inflammations was allowed and the score values of alkaline phosphatase of blood granulocytes were determined. During the four weeks after irradiation, a deviation in the activity of alkaline phosphatase towards higher values took place accompanied by weakening the retardation of the onset of the second cellular sequence of the artificial inflammatory reaction of big mononuclear formations. (auth)

44956 IRRADIATION OF CULTURE MEDIUM AND CHROMOSOMAL ABERRATIONS IN CULTURED NONIRRADIATED LYMPHOCYTES. Liniecki, J.; Bajerska, A. (Inst. of Occupational Medicine, Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Biol.; 18: No. 5, 293-6(Jun 1970).

The indirect action of irradiated blood serum or culture medium on chromosome aberrations in non-irradiated human lymphocytes was investigated. Lymphocytes from non-irradiated donors were added to x-irradiated culture medium, x-irradiated serum in non-irradiated culture medium, and x-irradiated culture medium and serum. Generally, acentric fragments seemed to be more frequent in those cultures to which blood was added immediately after irradiation. However, this could not be validated statistically ($p > 0.05$). All other aberrations were seen only sporadically and their frequency after irradiation did not seem to have increased. Because of numerous differences in the conditions of these experiments, the results could not be directly compared with those of other researchers. It is possible, however, that some indirect action of the irradiated body fluids upon the unreplicated chromosomes of lymphocytes and other cells exists. (E.E.H.)

44957 MYELOFIBROSIS WITH MYELOID METAPLASIA AND PANCYTOPENIA AFTER THOROTRAST INJECTION. Bastrup-Madsen, Poul; Nordentoft Jensen, Bjoern (Aarhus Amtsygehus, Denmark). Acta Med. Scand.; 189: 355-8(1971).

Twenty-two years after an injection of Thorotrast, myelofibrosis with extramedullary metaplasia of the spleen and lymph nodes developed in a man aged 50 years. Pancytopenia with erythroblasts and poikilocytes in the blood was present. The clinical picture was characterized by anemia, infections and hemorrhages, which ultimately led to death. The case is remarkable owing to the absence of splenomegaly. Both the spleen and the lymph nodes were the site of marked follicular atrophy, presumably evoked by radiation from the deposited thorium dioxide, which was also present in the liver and bone marrow. This radioactive material, which is assumed to have induced the myeloproliferative disorder, is also likely to have accentuated the pancytopenia. It is pointed out that some of the cases which are described in the literature as aplastic anemia after thorotrast injection had morphological changes in the red blood picture of the same type as in myelofibrosis. This diagnosis may be overlooked if the thorium radiation induces splenic atrophy instead of the splenomegaly which is otherwise a characteristic feature. (auth) (Sweden)

44958 ACUTE ERYTHRAEMIA (DI GUGLIELMO'S SYNDROME) AFTER THOROTRAST INJECTION. Bastrup-Madsen, Poul; Nielsen, Kai; Mose, C. B. (Aarhus Amtssygehus, Denmark. Herning Central Hospital, Denmark). Acta Med. Scand.; 189: 349-53(1971).

Fifteen years after an injection of Thorotrast a typical acute Di Guglielmo erythremia developed in a man aged 65 years. Death occurred a few months after the onset of the initial symptoms. Autoradiography revealed signs of alpha radiation in the liver and spleen. The role of thorium dioxide in the etiology of the disease is discussed. (auth) (Sweden)

44959 CHROMOSOME STUDIES OF RADIOLOGISTS AND TECHNICIANS IN RADIOLOGICAL LABORATORY. Zapata Gayon, Maria del Carmen; Funes Cravioto, Francisco; Marquez Monter, Hector (IMSS, Mexico City). Bol. Estud. Med. Biol.; 26: 43-51(1969). (In Spanish).

A study was conducted to determine the effects of x rays on chromosomes of peripheral blood lymphocytes in a group of radiologists and x-ray technicians (Group I). The results were compared with those in a non-exposed control group (Group 2) and in patients with a single diagnostic X-ray exposure (Group 3). An elevated frequency, statistically significant, of chromosomal aberrations was found in Group 1, in comparison with the other groups. It was concluded that at present insufficient security measures are taken for protection of both radiologists and technicians from the damaging effects of x-rays on somatic cells, and that the cytogenetic method can be useful to assess x-ray damage to chromosomes. (auth)

Radiation Effects on Plants

Refer also to abstracts 44765, 44769, 44786, 44787, 44790, 44791, 44804, 44825, and 44978.

44960 INFLUENCE OF ^{60}Co-RAYS ON THE ASCORBIC ACID CONTENT IN CORN [RYE AND WHEAT] SPROUTS GROWN FROM IRRADIATED SEEDS. Kulesza, J.; Antoszewska, L.; Kroh, J.; Rajchert, A. (Technical Univ., Lodz, Poland). Zesz. Nauk. Politech. Lodz., No. 100, Chem. Spozyw.; No. 14: 43-7(1968).

The radiation induced changes in the content of ascorbic acid in 4 day plants of Ostka Chlopicka wheat and Smolickie Ludowe rye have been investigated. The plants were grown from the seeds subjected to the following doses of ^{60}Co γ-radiation: 1, 5, 10, 20, 25, and 100 krads. The content of ascorbic acid was determined by titration and chromatography. For wheat the increase of ascorbic acid content and of other reducing substances was found for the doses within the range 5 to 25 krads. For 100 krads the content of ascorbic acid was lower than for 25 krads but higher than for the control. In the case of rye the content of ascorbic acid and other reducing substances was increased only for 1 krad dose. All other doses caused the decrease of AA content. (auth)

44961 CONTRIBUTION TO THE STUDY ON THE REPARATIVE EFFECT OF EXOGENOUS DNA IN THE IRRADIATED MERISTEM OF VICIA FABA. Slotova, Jana; Karpfel, Z.; Kubickova, Dagmar (Inst. of Biophysics, Brno). Biol. Plant. (Prague); 13: No. 2, 69-78(1971).

The participation of exogenous DNA in the process of postirradiation reparation of meristematic cells for Vicia faba primary roots was studied. Comparisons were made of the positive reparative effect of isologous DNA with postirradiation action of heterologous DNA in its native, thermally denatured, and DNAase-degraded forms, or DNA degraded by ultrasound, and with the effect of other biologically important macromolecules (RNA, histone, heparin, and dextran sulfate). The roots of Vicia faba irradiated by 150 R exposure were cultivated in solutions containing the above substances for an appropriate time interval. The mitotic activity of the cell population and the frequency of postmetaphase chromosomal aberrations induced by radiation were evaluated. It was found that a stimulation of cell division and reparation of chromosome damages were supported exclusively by isologous DNA. On the contrary, exogenously applied heterologous DNA increased postirradiation frequency of aberrations; maintenance of native structure of applied DNA was an essential condition for the above effect. Other macromolecules investigated were without effect. (auth)

44962 SENSITIVITY OF SOME RADIOMUTANTS OF COTTON TO GAMMA RADIATION. Leukhina, T. N.; Nazirov, N. N. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 1, 63-4(1971). (In Russian).

The radiosensitivity of several cotton plant mutants with and without the early-ripening qualities of the original plants was investigated. Dry seeds were irradiated in a γ field at a dose rate of 15 R/sec, for total dosages of 10 and 20 R. Preliminary data support the assumption that the radiosensitivities of different types of cotton may be genetically linked to their early-ripening characteristics. (K.S.W.)

44963 EXPERIMENTS ON THE RELATION BETWEEN THE BIOLOGICAL EFFECTS OF IONIZING RADIATION AND MAGNETIC FIELDS. II. COMBINED EFFECTS OF IONIZING RADIATION AND MAGNETIC FIELDS ON ROOT GROWTH IN VICIA FABA. Santha, Andras. Honvedorvos; 20: 198-205 (Apr-Jun 1968). (In Hungarian).

Investigations designed to clarify the antagonistic effects of ionizing radiations and magnetic fields were continued. Based on 10-day observations, the germination of Vicia faba seeds under the influence of prolonged (72 hr) exposure to a constant homogeneous magnetic field occurred, statistically, more rapidly than was the case with untreated control seeds. X irradiation (200 to 600 R) or ^{60}Co γ irradiation inhibited growth of the seedlings in direct proportion to the dose. However, if the seedlings were subjected to a magnetic field for 72 hr before irradiation, the post-irradiation growth of the seedlings was more rapid than that of the control plants (exposed only to irradiation). Thus, exposure to a magnetic field improved the stability of the seedlings to irradiation. Under the given conditions however, the protective effect of the magnetic field was not sufficient to completely remove the radiation effect. The possible mechanisms for this action are discussed, though the mechanism itself remains unknown. (tr-auth)

XUM

44964 INFLUENCE OF TEMPERATURE ON RADIATION-INDUCED OXYGEN-DEPENDENT AND -INDEPENDENT DAMAGE IN BARLEY SEED. Conger, B. V.; Hileman, J. R.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman). Contract AT(45-1)-353. Radiat. Res.; 46: No. 3, 601-12(Jun 1971). (RLO-353-40).

Himalaya barley seeds of 10.0% water content were subjected in vacuo to various exposures of ^{60}Co γ rays at different temperatures ranging from −78 to 50°C. In one set of experiments the seeds were soaked immediately after irradiation in either oxygenated or oxygen-free water at 0°C. In another series, the seeds were stored in vacuo for various periods of time at different temperatures before soaking. The oxygen enhancement ratio was greatest in seeds irradiated at lower temperatures and decreased as the irradiation temperature was increased until there was no observable oxygen-effect (OER = 1) when the seeds were irradiated at 50°C. Although oxygen-dependent damage decreased with increasing irradiation temperature, oxygen-independent damage increased. A decrease in oxygen-dependent damage during storage was observed with increasing storage temperature. The development of a long-term oxygen-independent damage component became apparent in irradiated seeds stored at 40 and 50°C. Otherwise, there was no storage response if the seeds were soaked in oxygen-free water after postirradiation storage. Radioinduced free radicals which were not associated with oxygen-dependent damage were also observed. (auth)

44965 POWER RELATIONS AS AN EXPRESSION OF RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) IN TRADESCANTIA STAMEN HAIRS. Underbrink, A. G.; Sparrow, A. H. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 46: No. 3, 580-7(Jun 1971).

Neutron doses at 0.43 MeV and at a lower average energy level were plotted against x-ray doses required to produce equal effects in various frequencies of response for eight somatic aberrations found in Tradescantia stamen hairs. Such plots serve as a useful graphic method for expressing RBE values which change as a function of absorbed dose. It was found that the relationship of neutrons of either energy to x-rays for equal irradiation effects changed as a simple power function and, therefore, was linear on log−log plots. The power functions were interpreted as resulting from increased effectiveness of x rays compared to neutrons as the dose increased. Seven types of somatic aberrations shared the same power function and may thus be produced by radiation acting similarly on a common entity, i.e., the chromosomes or constituent DNA molecules. An eighth type of aberration appeared to be fundamentally different from the others. (auth)

44966 ANALYSIS OF THE DOSE VERSUS EFFECT CURVES AND POSTRADIATION RECOVERY OF YEASTS IRRADIATED WITH GAMMA RADIATION ON THE BASIS OF VARIOUS CRITERIA OF SURVIVAL. Benevolenskii, V. N.; Meshcheryakova, O. M. Radiobiologiya; 11: No. 1, 80-5(Jan-Feb 1971). (In Russian).

The parameters of the dose curves (n and α) and the curves of postradiation recovery (k and β) in the case of gradual inclusion of microcolonies with a smaller number of cells than are contained in the normal disc-shaped colonies in the test effect to be recorded were determined in investigations on diploid yeast cells Saccharomyces ellipsoides, subjected to the influence of γ radiation. The data obtained were analyzed according to the hypothesis of potential damages and the stochastic concept of the development of radiation damage. (tr-auth)

44967 RADIOSTIMULATION OF THE GROWTH OF CHLORELLA AT VARIOUS STAGES OF THE CELLULAR CYCLE. Rogatykh, N. P. (Inst. of General Genetics, Moscow). Radiobiologiya; 11: No. 1, 92-5(Jan-Feb 1971). (In Russian).

Synchronous cultures of Chlorella were irradiated with β particles at a dose of 640 rad at various stages of the cellular cycle. A stimulation of growth was observed after irradiation in the G_1 stage. After irradiation in the G_2 stage, growth slowed down. On the average, for the S stage there is no effect, although irradiation influences the rate of growth. For a culture irradiated with 3 Krad of γ rays at the beginning of the G_1 stage, it was shown that DNA synthesis in it begins earlier than in the control (the G_1 stage is contracted), and the total amount of DNA synthesized in one cycle is somewhat higher. (tr-auth)

44968 STUDIES ON THE CELLULAR METABOLISM IN MICROORGANISMS AS INFLUENCED BY GAMMA IRRADIATION. V. ON THE MEMBRANE PERMEABILITY CHANGES AND LEAKAGE OF CELLULAR CONSTITUENTS OF IRRADIATED YEAST CELL. Kim, Jong Hyup; Chun, Sae Yul; Choi, Yun Soon; Kim, Hee Ja. Korean J. Microbiol.; 6: No. 2, 54-62(1968). (In Korean).

The effects of γ radiation on yeast cells Sacch. cerevisiae and the leakage of cellular constituents such as carbohydrates, ribose, amino acids, inorganic phosphates, and organic phosphates were studied. Samples of yeast cells were washed and starved intensively and radiation effects were compared with those of controls (unstarved). The irradiation dose ranged from 24 kR. up to 480 kR. The loss of 260 mμ absorbing material was also observed. Mechanisms of membrane damage by gamma irradiation are discussed in relation to permeability changes and loss of substances. (Korean Sci. Abstr.)

44969 ABERRATIONS IN CREPIS CAPILLARIS CHROMOSOMES INDUCED BY ^{3}H-THYMIDINE. Shevchenko, V. V. (Inst. of Developmental Biology, Moscow). Genetika; 7: No. 5, 15-22(May 1971). (In Russian).

The pattern of cytogenetic action of ^{3}H thymidine (20 μCi/ml; 8,6 Ci/mmole; 6 hours' treatment) on Crepis capillaris seedlings was investigated. It was found that ^{3}H-thymidine induced aberration only after incorporation into the chromosomes at S-period. The cells being at G_1 or G_2 period at the time of isotope treatment exhibited no aberrations. In the first mitosis only chromatid aberrations were observed. In the second mitotic cycle the breaks occurred at all the stages of the cycle and both chromosome and chromatide aberrations were found. The frequency of different types of chromatid aberrations induced by ^{3}H-thymidine in the cells at S-period differed from that observed after x ray treatment of such cells. The location of chromosome breaks in two aberration types (isochromatid deletions and chromatid exchanges) was similar to that after x ray, proton, neutron, and ^{90}Sr irradiations. It was assumed that the high frequency of breaks in definite regions of chromosomes of Crepis capillaris after treatment with some chemical mutagens was not due to a high concentration of thymine in these regions. (auth)

44970 RADIATION DAMAGE TO ENDOMYCES VERNALIS AND ITS RELATIONSHIP TO THE LIPID CONTENT AND THEIR ANTIOXIDANT ACTIVITY. Burlakova, E. V.; Parkhomenko, I. M.; Ryazanov, V. M. (Moscow State Univ.). Radiobiologiya; 11: No. 2, 190-4(Mar-Apr 1971). (In Russian).

The radiosensitivity of Endomyces vernalis was studied under various conditions of pre- and postradiation culturing. It was discovered that the radiosensitivity is correlated with the lipid content at the moment of irradiation. In the case of culturing on a medium where the lipid content in the fungus was 10 to 16% of the dry weight, LD_{37} was equal to 15 kR; on a medium where the lipid content was increased to 26 to 39% of the dry weight, LD_{37} was 8 kR. The conditions of postradiation culturing did not influence the radiosensitivity of Endomyces vernalis. It was found that changes in the antioxidant activity of the lipid fraction of Endomyces vernalis occurred only in a radiosensitive culture and were determined chiefly by changes in the cephalin-containing fraction of the phospholipids. (tr-auth)

44971 EFFECT OF REPEATED IRRADIATION OF SEEDS AFTER STORAGE. Riza-Zade, R. R.; Suleimanova, N. L. Scientific Research Inst. of Agriculture, Baku). Radiobiologiya; 11: No. 2, 206-7(Mar-Apr 1971). (In Russian).

It was established in field experiments that prolonged storage of irradiated sunflower seeds (at a stimulating dose of 2 kR and an inhibiting dose of 20 kR) for more than a month after irradiation leads to removal of the effect of radiation to the extent that repeated irradiation at the same doses before planting had an effect quantitatively analogous to a single irradiation 1 to 10 days before planting. (tr-auth)

44972 HIGH RESISTANCE OF RAPE AND TURNIP TO GAMMA IRRADIATION. Shnaider, T. M. (Inst. of Experimental Biology, Kharku, USSR). Radiobiologiya; 11: No. 2, 253-7 (Mar-Apr 1971). (In Russian).

Experiments were conducted to determine the radiosensitivity of various varieties of rape and turnip, using the survival of the plants, the rate of growth and development of the plants, and the suppression of growth of roots of seedlings as the criteria of radiosensitivity. It was established that in the γ irradiation of dry seeds of spring rape and turnip, doses of 200 to 220 kR are critical, while a dose of 300 kR is lethal for these crops. The conclusion reached was confirmed by the results of cytological analysis of chromosome aberrations in the meristem of the roots of rape and turnip seedlings. (tr-auth)

44973 DYNAMICS OF THE EXCRETION OF CELL METABOLITES DURING THE POST-RADIATION RECOVERY OF YEASTS. Angepova-Latarinskaya, E.; Kuzin, A. M. (Inst. of Plant Physiology, Sofia. Inst. of Biophysics, Pushchino, USSR). Radiobiologiya; 11: No. 2, 275-8(Mar-Apr 1971). (In Russian).

It was found that in the first hours of recovery of an irradiated culture of Torulopsis utilis (100 kR), there is a substantial excretion of substances with maximum absorption at 266 mμ (nucleotides and their derivatives). The excretion ended when intensive recovery of the irradiated culture began. (tr-auth)

44974 ROLE OF SULFHYDRYL GROUPS IN THE DETERMINATION OF THE NATURAL RADIOSENSITIVITY OF VICIA FABA AND TRITICUM SEEDLINGS. Semerdzhyan, S. P.; Nor-Arevyan, N. G. (Scientific Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya; 11: No. 2, 278-81(Mar-Apr 1971). (In Russian).

The radiosensitivity of plants as a function of the rate of growth of the roots (Vicia faba) and the ploidy (Triticum) was compared with the general content and level of acid-soluble SH-groups in two-millimeter root tips. As a result of the experiments on various lines of Vicia faba and polyploid forms of Triticum, differing in radiosensitivity, a direct correlation was established between the resistance of the plants to ionizing radiation and the thiol level in the root meristem. (tr-auth)

44975 CORRELATION OF THE RADIORESISTANCE OF VICIA FABA ROOTS WITH THEIR CONTENT OF THIOL COMPOUNDS. Nor-Arevyan, N. G.; Semerdzhyan, S. P. (Scientific Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya; 11: No. 2, 281-4(Mar-Apr 1971). (In Russian).

The natural radiosensitivity of Vicia faba seedlings, differing in the rate of root growth and the distribution of SH groups contained in three different zones of rapid- and slow-growing roots, was studied. Seedlings with rapidly growing roots were more radiosensitive than those with slow growing roots. It was found that the total content and the content of acid-soluble SH-groups in the root tips were higher than near the base. A direct correlation was established between the radioresistance of the seedlings and the SH-group content in the root. (tr-auth)

44976 RESISTANCE OF CARRAGEEN AND INDIGO BUSH TO GAMMA RAYS. Kudinov, M. A. (Central Botanical Garden, Minsk). Radiobiologiya; 11: No. 2, 292-4(Mar-Apr 1971). (In Russian).

The lethal and critical doses for seven species of carrageen and four species of indigo bush, woody plants from the legume family are reported. These data were obtained in a field experiment as a result of a single irradiation of the seeds. The resistance and phylogenesis of the species were compared. (tr-auth)

Radiation Effects on Microorganisms

Refer also to abstract 44804.

44977 COMPARISON OF THE DIRECT EFFECT OF γ RAYS ON ESCHERICHIA COLI RIBOSOMES AND BACTERIOPHAGE f2. Petranovic, Dragutin; Pecevsky-Kucan, Ira; Kucan, Zeljko (Inst. Rudjer Boskovic, Zagreb). Radiat. Res.; 46: No. 3, 621-30(Jun 1971).

Gamma-radioinduced inactivation of the ability of Escherichia coli MRE 600 ribosomes to support polyuridylic acid-directed polymerization of phenylalanine was compared with the inactivation of the reproductive capacity of bacteriophage f2. In lyophilized preparations of the mixture of the two ribonucleoproteins irradiated at +20°C, both components were four to five times more radiosensitive than when fully protected. The full protection of ribosomes, resulting in a D_{37} of 2.2 MR, was obtained when a suspension or a lyophilized preparation was irradiated at −80°C or when oxidized glutathione was present in lyophilized preparations irradiated at +20°C. A combination of the two treatments did not result in a further increase in radioresistance. Bacteriophage f2 irradiated at −80°C was not fully protected, and the addition of high concentrations of oxidized glutathione or Bacto-Tryptone was needed to reach maximum protection and a D_{37} of 1 MR. At full protection, the bacteriophage was inactivated by approximately one hit to its RNA, while about eight hits per 70S ribosome were needed to impair its function. (auth)

44978 PECULIARITIES OF THE RADIOBIOLOGICAL RESPONSES OF SINGLE-CELLED ORGANISMS WITH DIFFERENT ORGANIZATIONS OF THE NUCLEAR APPARATUS. Korogodin, V. I.; Korogodina, Yu. V.; Sokurova, E. N.; Kharlomova, L. A. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 11: No. 1, 3-16(Jan-Feb 1971). (In Russian).

Different types of single-celled eukaryotes were characterized by their own, specific form of relation of radiobiological responses to the degree of ploidy and the number of nuclei in the cell. In yeasts in the stationary phase of growth, haploid mononuclear cells, on the one hand, and diploid, polyploid, and polynuclear cells, on the other, differ both in degree of γ-radiosensitivity and in qualitative peculiarities of the manifestation of responses to irradiation. In single-celled algae the differences between haploid and diploid cells with respect to responses to irradiation are evidently only quantitative (the haploids are more sensitive than the diploids), while the qualitative peculiarities of the radiobiological responses are similar in the two groups. Finally, in protozoa, and, in particular, in amoebas, neither the degree of ploidy nor the number of nuclei in the cell decisively influences either the qualitative or the quantitative aspects of responses to irradiation. The causes of such a varied influence of the structural organization of the nuclear apparatus on the radiobiological responses of different types of single-celled organisms are not clear. (tr-auth)

44979 PROTECTION OF STREPTOCOCCUS FAECALIS WITH γ-IRRADIATION AGAINST THE BACTERICIDAL EFFECT OF POTASSIUM PERMANGANATE. Plecas, M. (Inst. of Hygiene, Bucharest). Arch. Roum. Pathol. Exp. Microbiol.; 28: No.2-3, 563-7(Jun-Sep 1969).

In the case of the combined effect of γ irradiation and potassium permanganate on Streptococcus faecalis, the bactericidal effect was less than when bacteria were treated with potassium permanganate only. This phenomenon was due to neutralization of $KMnO_4$ with γ rays and was not observed in similar studies with the following bactericides: thiomersal, formaldehyde, iodine, cetyl pyridinium bromide, mercuric chloride, sodium benzoate, phenol, benzoic acid, lactic acid, and boric acid. (auth)

44980 ROLE OF MACROMOLECULAR SYNTHESIS IN THE UV-INDUCED MUTAGENESIS IN SACCHAROMYCES CEREVISIAE. Kuznetsova, O. B. (Inst. of Atomic Energy, Moscow). Genetika; 7: No. 5, 95-107(May 1971). (In Russian).

A 5 hour incubation of yeast cells in liquid medium after uv irradiation at low doses resulted in an increase in the frequency of reverse mutations in the ur- and try-loci. This phenomenon was due to additional reversions arising during the intensive DNA synthesis. The inhibition of DNA synthesis during the post-irradiation period made it possible to decrease the rate of reverse mutations to the level observed when cells were plated immediately after uv treatment. The inhibition of protein synthesis resulted in the inhibition of DNA synthesis. Under these conditions the decrease of uv mutagenic effect corresponded only to the degree usually observed as a result of DNA synthesis inhibition. The loss of photoreversibility of uv-induced reverse mutations took place immediately after irradiation, before beginning of the DNA synthesis. It was assumed that the postirradiation DNA synthesis in yeast is not necessary for the formation of the most part of reverse mutations selected on minimal agar medium. (auth)

44981 POSSIBILITY OF STERILIZATION OF SYNTHETIC PREPARATIONS FROM TYPHOID BACILLI BY MEANS OF IONIZING RADIATION. Tumanyan, M. A.; Duplishcheva, A. P.; Sinilova, N. G.; Ivanov, K. K. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol.; No. 4, 120-5(Apr 1971). (In Russian).

The possibility of using ionizing radiation for sterilization of antigenic preparations from S. typhi was studied. It was found that γ irradiation of water solutions of O-antigens of S. typhi, in doses ranging from 0.1 to 50 Mrad, caused a gradual destruction of the antigen macromolecule. Despite certain changes of physicochemical and chemical indexes after the irradiation of the antigen with doses up to 3 Mrad, this failed to be reflected either on serological, immunogenic, or on antigenic or other biological properties of the preparations. Consequently, the irradiation dose under 3 Mrad inclusively can be used for sterilization of water solutions of somatic O-antigens of S. typhi. (auth)

44982 INFLUENCE OF GAMMA RADIATION AND ULTRAVIOLET LIGHT ON THE POLYNUCLEOTIDE PHOSPHORYLASE ACTIVITY OF LYSOGENIC AND NONLYSOGENIC STRAINS OF E. coli. Guberniev, M. A.; Kolobov, A. V.; Abidova, M. (Scientific Research Lab. of Experimental Immunobiology, Moscow). Radiobiologiya; 11: No. 2, 170-3(Mar-Apr 1971). (In Russian).

The effects of γ and UV radiation on the activity of polynucleotide phosphorylase (PNPase) in E. coli K-12 (λ) and E. coli B were studied. It was found that γ and UV rays in definite doses induced an activation of PNPase in bacteria. A direct dependence of the specific activity of the enzyme on the time of incubation after irradiation of lysogenic and nonlysogenic strains of E. coli was detected. A hypothesis on the participation of PNPase in the mechanism of the postradiation degradation of bacterial RNA was advanced. (tr-auth)

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44983 INVESTIGATION OF THE MULTIPLICATION OF COMMON HERPES VIRUS IN GAMMA IRRADIATED CULTURES OF HUMAN CELLS. Andonov, P.; Todorov, S.; Dundarov, S.; Ivanov, B.; Mineva, E. (Inst. of Epidemiology and Microbiology, Sofia. Inst. of Radiology and Radiation Hygiene, Sofia). Radiobiologiya; 11: No. 2, 224-9(Mar-Apr 1971). (In Russian).

The production of common herpes virus in cultures of human cells irradiated with γ rays at various doses was studied. It was established that with doses of irradiation less than 20 kR virus production does not undergo any significant changes, at 50 kR it is suppressed, at 100 kR it is reduced to a minimum, and at 350 kR it is absent. In cells infected 24 and 48 hrs after irradiation, the virus multiplied better than in cells infected directly after irradiation. The glucose consumption decreased with increasing dose of irradiation; the amount of lactic acid in the nutrient medium remained at the same level or increased, the pigment content decreased after irradiation at doses above 50 kR. The number of cells labeled with thymidine-^{3}H also decreased with increasing dose of irradiation. (tr-auth)

44984 INVESTIGATION OF THE RADIOSENSITIVITY OF E. COLI B IN IRRADIATION BY HEAVY IONS. Grigor'ev, Yu. G.; Krasavin, E. A.; Ryzhov, N. I.; (and others). Radiobiologiya; 11: No. 2, 245-8(Mar-Apr 1971). (In Russian).

The inactivating effect of heavy ions, H, He, B, C, Ne, and Ar, of various energies on bacterial cells of E. coli B under normal conditions and in an atmosphere of nitrogen is discussed. The coefficients of the relative biological effectiveness of heavy ions proved to be less than one. The degree of expression of the oxygen effect decreased with increasing specific energy losses (dE/dx) of radiation. The ambiguity of the relationship between the cross-section of inactivation of E. coli and dE/dx of the ions is discussed. It is necessary to consider not only dE/dx of the radiations but also the radial distribution of absorbed energy in the track of the charged particles in an analysis of changes in the cross-section of inactivation. (tr-auth)

44985 INFLUENCE OF THE TEMPERATURE OF INCUBATION IN THE POSTRADIATION PERIOD ON THE SURVIVAL OF IRRADIATED MICROORGANISMS. Frumkin, M. L.; Bushkanets, T. S.; Gadzhimuradov, M.-I. M. (All-Union Scientific Research Inst. of the Canning and Vegetable-Drying Industry, Moscow). Radiobiologiya; 11: No. 2, 295-7(Mar-Apr 1971). (In Russian).

The effects of the incubation temperature following irradiation of meat on the survival of microorganisms isolated from the residual flora of the meat were studied. It was found that the survival of radioresistant spore bacilli and micrococci immediately after irradiation and after exposure at 0 and 25° was essentially unchanged. It was concluded that lowering the temperature to 0° during the first hours after irradiation did not promote postradiation recovery of the microflora of the irradiated meat, which created the most optimum conditions for the suppression not only of biochemical, but also of microbiological processes. (tr-auth)

Radiosterilization and Radiopreservation

Refer also to abstract 44985.

44986 (TID-25749) BACTERIOPHAGES OF CLOSTRIDIUM BOTULINUM AND CLOSELY RELATED ORGANISMS. Final Summary. Eklund, M. W.; Poysky, F. T.; Smith, C. A.; Reed, S. M. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Jul 1970. Contract AT(49-7)-2442. 23p. Dep. NTIS.

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 44490 and 45103.

44987 (AECL–3901) BAGPIPE: A PROGRAM TO DETERMINE THERMOELASTIC DEFORMATIONS IN A HOLLOW CYLINDER OF FINITE LENGTH. Crozier, R. J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1971. 36p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The Fortran program BAGPIPE is designed to determine the thermo-elastic deformations which arise in a hollow circular cylinder of finite length. The inner and outer surfaces of the cylinder are subjected to temperature changes, normal stresses and shear stresses, all of which may vary along the length of the cylinder. The length of the cylinder may change. The preparation of input data has been made particularly simple and the central processor time required to execute a typical problem is of the order of 15 seconds. The problem of the non-uniform heating of a fuel sheath containing fuel pellets separated by thin, highly conductive discs is used as an illustration. It is found that the sheath does not experience unrealistic non-uniform deformations when subjected to a temperature distribution proposed at Chalk River Nuclear Laboratories. (auth)

44988 (CONF-700218–(Vol.1)) SYMPOSIUM ON MATERIALS SCIENCE RESEARCH, NATIONAL AERONAUTICAL LABORATORY, BANGALORE, FEBRUARY 24–27, 1970. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 525p.

Fifty-nine papers were presented at the conference. Twenty-four of the papers are included in Vol. 1. A separate abstract was prepared for each of 12 papers. The remaining papers contain information on materials for defense and aerospace, electronics, and nonferrous alloys that is not in scope for NSA. (R.C.K.)

For abstracts of individual papers see: 44430, 44990, 45004, 45056–45061, 45102, 45146, and 45603.

44989 (CONF-700218–(Vol.2)) SYMPOSIUM ON MATERIALS SCIENCE RESEARCH, NATIONAL AERONAUTICAL LABORATORY, BANGALORE, FEBRUARY 24–27, 1970. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 495p.

Fifty-nine papers were presented at the conference. Thirty-five of the papers are included in Vol. II. A separate abstract was prepared for each of 14 papers. The remaining papers contain information on strengthening mechanisms, corrosion phenomena, powder metallurgy, experimental techniques, and defects and imperfections that is not in scope for NSA. (R.C.K.)

For abstracts of individual papers see: 44375, 45005, 45028, 45062–45064, 45085–45087, 45107, 45110, 45126, 45147, and 45568.

44990 METALS IN DEFENSE. Tamhankar, R. V. (Defence Metallurgical Research Lab., Hyderabad, India). pp 1-34 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218–(Vol.1).

A review of metals and alloys of importance in production of defense hardware is presented. Special alloys and metals and their properties are emphasized to show their place in defense requirements. Information is included on steels, copper and copper alloys, magnesium and magnesium alloys, zinc and zinc alloys, alloys of tin, lead, antimony, and aluminum, magnetic materials, superalloys, refractory metals, titanium and titanium alloys, and other alloys. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 44489.

44991 (AEC-tr–7176) CORROSION OF YTTRIUM. Al'tovskii, R. M.; Gornyi, D. S.; Eremin, A. A.; Panov, A. S. Translation of Korrozionnye Svoistva Ittriya, Atomizdat, Moscow, 1969. 87p. (TT–70–50156; IPST-Cat.–5847). Dep. NTIS.

Published data on corrosion resistance and compatibility of Y are presented and summarized. Data and information on Y alloys are also included. (J.R.D.)

44992 (AEC-tr–7235) INFLUENCE OF ADDITION ELEMENTS AND OF THE STRUCTURE ON ZIRCONIUM ALLOYS IN WATER AND STEAM AT HIGH TEMPERATURE. Blanchet, J.; Coriou, H.; Grall, L.; Olivier, P.; Pelras, M. Translated from Energ. Nucl. (Paris); 11: 345-56(1969). 19p. Dep. NTIS.

The ternary alloy Zr–1% Fe–1% Cu shows good oxidation resistance to 500°C steam. Among the four investigated metallurgical states, the behavior of specimens corresponding to the β-annealed state followed by quenching must be pointed out. It was demonstrated that this treatment leads to a nearly complete solution of the second-phase precipitates; holding at 500°C during corrosion is equivalent to tempering and leads to a fine and well distributed precipitation. The very regular structure thus obtained results in an alloy having not only an excellent resistance to oxidation but also a relatively low degree of hydrogenation. Oxygen diffusion into the metal remains small even though it cannot be neglected at 500°C. It seems that the oxidation mechanisms involved in 500°C steam, on one hand, and in 360°C water and 400°C steam, on the other, are different as shown by the comparative study of the corrosion of the investigated alloys and of Zircaloy 2 in these media. It was demonstrated that additions of niobium (0.2 and 1%) or of chromium (1%) in the ternary alloy Zr–1% Fe–1% Cu have an unfavorable effect on the oxidation resistance of this alloy in superheated steam at 500°C. (auth)

44993 (BMI–1907) SURVEY AND ANALYSIS OF MATERIALS WEAR AND FRICTION IN SODIUM. Glaeser, William A. (Battelle Memorial Inst., Columbus, Ohio). Jun 1971. Contract W-7405-eng-92. 46p. Dep. NTIS.

A survey was made to determine the current state of wear and friction problems in FFTF core components and in-vessel fuel handling machine (IVHM) components and to investigate the application of current wear theory to the selection of materials, interpretation of test data, and engineering design. Although FFTF components were of principal interest, longer range materials considerations were also incorporated in the study. Results of the survey indicate that wear data from conventional wear tests cannot be applied to the detailed design requirements of the FFTF core and IVHM components. Since testing of full-scale components is impractical, design simulation tests must be evolved which are based upon specific component design parameters such as contact geometry, relative motion, type of motion, area ratios, contact loading, sodium chemistry, and adhesion or friction levels. (auth)

44994 (COO–2018–18) STRESS CORROSION CRACKING OF Fe–Cr–Ni ALLOYS IN CAUSTIC ENVIRONMENTS. Quarterly Report, January 15–April 14, 1970. Agrawal, A. K.; Staehle, R. W. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). 23 Feb 1971. Contract AT(11-1)-2018. 56p. Dep. NTIS.

Results of stress corrosion and electrochemical studies are reported for Fe-Cr-Ni alloys exposed to NaOH-H_2O solutions at temperatures below 200°C. Stress corrosion cracking of 304 stainless steel does not occur in boiling caustic solutions of 50% or lower concentrations. Pitting and transgranular type cracking occurs at only certain potentials. The electrochemical studies show that increasing temperature and/or caustic concentration causes more rapid dissolution of protective films on alloys. Replacement of Ni by Cr in Fe-Ni increases the corrosion rate several fold. (auth)

44995 (COO–2018-21) STRESS CORROSION CRACKING OF Fe–Cr–Ni ALLOYS IN CAUSTIC ENVIRONMENTS. Quarterly Report, April 15–July 14, 1970. Agrawal, A. K.; Staehle, R. W. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). 5 Mar 1971. Contract AT(11-1)-2018. 55p. Dep. NTIS.

Results from stress corrosion and electrochemical studies are reported for Fe-Cr-Ni alloys exposed to NaOH-H_2O solutions at temperatures below 200°C. Sensitized 304 stainless steel, as compared with annealed 304 stainless steel is more prone to stress corrosion cracking, and is unsuitable for either anodic or cathodic protection. Principal cause of failure is intergranular cracking. Cathodic polarization results show that hydrogen evolution on Fe-Cr-Ni alloys occurs at a potential of approximately –1.1 V (SCE). Increase in temperature slightly shifts the hydrogen evolution potential to less negative values. Cathodic kinetics, relative to anodic kinetics, is independent of alloy composition, caustic concentration, and temperature. (auth)

44996 (COO–2018-23) STRESS CORROSION CRACKING OF Fe–Cr–Ni ALLOYS IN CAUSTIC ENVIRONMENTS. Quarterly Report, July 16, 1970–October 14, 1970. Agrawal, A. K.; Staehle, Roger W. (Ohio State Univ. Research Foundation, Columbus). Apr 1971. Contract AT(11-1)-2018. 38p. Dep. NTIS.

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Results from stress corrosion and electrochemical studies are reported for Fe–Cr–Ni alloy exposed to NaOH–H_2O solutions at temperatures below 200°C. The corrosion potential of Type 430 stainless steel in caustic solutions (<60% NaOH) is considerably higher than that of Type 304 stainless steel. The stress corrosion cracking of 430 stainless steel as compared with 304 stainless steel occurs rapidly and in low concentrated caustic solutions (30% NaOH). The attack on 430 stainless steel is predominantly intergranular with some pitting. Design of an electrochemical cell suitable for electrokinetic investigation of metals at high temperatures in fused NaOH is given. (auth)

44997 (COO–2069–16) STUDY OF THE MECHANISMS OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM IN CHLORIDE ENVIRONMENTS. Quarterly Report, July 1–September 30, 1970. Slater, J. E.; Staehle, R. W. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). 10 Mar 1971. Contract AT(11-1)-2069. 69p. Dep. NTIS.

Work is reported on the effects of sensitization on stress corrosion cracking (SCC) behavior and on corrosion rate; studies have also continued on the corrosion morphology of commercial stainless alloys in $MgCl_2$, and on binary alloy dissolution. Circulating autoclave studies in water at 200°C containing 2 ppM Cl^- and 0.75 ppM O_2 have shown that sensitization has little effect on the SCC behavior of type 304 steels. Preliminary tests on sensitized 304 in the Huey and Strauss solutions have shown that maximum corrosion rates in the Huey solution occur after sensitization at 700 to 800°C but at 900°C in the Strauss solution. Results from scanning electron microscope (SEM) studies on stressed Fe–Cr–Ni alloys in $MgCl_2$ have continued to emphasize the importance of surface film formation, rupture, and reformation on the SCC process. Activation energy determinations for the dissolution of Fe–Ni alloys in H_2SO_4 have confirmed that dissolution can be described by the equation $\Delta G_a^* = N_{Fe}\Delta G_{Fe}^* = N_{Ni}\Delta G_{Ni}^*$. (auth)

44998 (EUR–4460) COMPATIBILITY OF Zr–2,5 PERCENT Nb SAMPLES WITH Na AT 400°C. Henry, B. (European Communities, Brussels (Belgium). Commission). 1970. 14p. (In French). NTIS (U. S. Sales Only).

The oxidation and hydridation in sodium at 400°C of samples of Zr–2.5% Nb removed from pressure tubes for a nuclear reactor were evaluated at the end of processing for 1000 hours in a sealed tube. The experiment, which is connected with the project for the irradiation of this material covered by liquid metal, makes use of relatively impure sodium. Under these environmental conditions it was demonstrated that the oxidation of the Zr–2.5% Nb alloy remained slight and that hydridation is important but can be prevented by a preliminary surface oxidation treatment. (tr-auth)

44999 (SAN–595–4) ALKALI METAL TWO-PHASE FLOW INVESTIGATION. Final Report. Linhardt, Hans D. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.). 17 May 1967. Contract AT(04-3)-595. 113p. Dep. NTIS.

The final results of a potassium turbine erosion investigation are presented. The program consisted of three tasks: Task I, droplet size determination, Task II, potassium turbine erosion test, and Task III, potassium turbine two-phase flow analysis. Under Task I the potassium condensate droplet sizes were experimentally determined for typical thermodynamic expansion processes in the $1000°F < T < 1500°F$ temperature range and theoretical quality condition $0.80 < X < 0.95$. For this purpose, a forced convection, boiling-condensing, closed loop potassium facility was developed. The potassium loop provided the specified potassium vapor conditions to the test section which consisted of various expansion nozzles and nickel plated wedge specimens placed downstream of the nozzle. After performance of seven (four to five hours) short duration tests, the wedge erosion damage lengths were measured and correlated with two-phase flow theory. The analysis of the test data provided internally consistent, accurate, and reproducible information on free stream droplet sizes. The significant result of Task I is that the measured average free stream droplet size is an order of magnitude larger than the average droplet size predicted by present condensation theories. In addition, the exploratory program has proven that the selected nozzle-wedge erosion method works and, therefore, should be utilized for future more detailed two phase flow investigations. Under Task II a supersonic potassium turbine was designed, fabricated and tested within the closed loop potassium test facility. The test turbine, which was made of TZM molybdenum material with four different blade geometries, was run for 96 hours at an average shaft speed of 17,800 rpm, the average turbine stagnation condition was 1250°F and 5.6 psig and theoretical nozzle exit vapor quality of x = 0.85. The most prominent feature evident on inspection of the turbine wheel was an erosion groove starting at the leading edge near the root of each blade and then continuing in a radial direction to the blade tip immediately behind the leading edge on the convex side of the blade. In addition, two of the three partial admission turbine nozzles experienced a large amount of what appeared to be corrosion with large deposits visible on the nozzle walls. It is believed that a puddle of liquid K accumulated downstream of the corroded nozzle area, from which large liquid potassium droplets were shed. The impingement of these secondary droplets upon the turbine wheel would explain the erosion groove on each blade. The small amount of erosion visible on the concave and convex side of the blades near the leading edge is attributed to the impingement of primary or free stream potassium droplets. It is recommended that the corrosion be eliminated by redesign of the nozzles and a more stringent control of the oxygen level during loop operation. The objective of Task III was to derive an engineering estimate of the limiting tip speed of supersonic potassium turbines operating within the temperature range from 1000 to 1500°F and with nozzle vapor exhaust qualities ranging from 80 to 95 percent. For this purpose, the experimental results of Task I and Task II have been considered in conjunction with a theoretical treatment of the wet vapor dynamics. The latter treatment includes analysis of the gas dynamic shock zone, the relaxation zone, and the velocity and thermal equilibration zone. In addition, the process of fluid collection on blades and droplet shedding from liquid layers formed on stationary blades have been explored analytically prior to the discussion of the wet vapor turbine performance trends. The experimental and theoretical results indicate that a properly designed supersonic single-stage potassium turbine should not have a vapor quality type of tip-speed limit for the quality range of interest. However, further experimental work is required to substantiate the analysis and, subsequently, to provide a solution for a two-stage supersonic, erosion-free, potassium turbine design. (auth)

45000 OXIDATION PROPERTIES OF WC3015. Tavassoli, A. A. (Marshall Space Flight Center, Huntsville, Ala.). Met. Trans.; 2: No. 7, 1985–6(Jul 1971).

Oxidation properties of a new niobium alloy, WC3015, were studied and compared to Cb752. Neither alloy could survive a 4 hr exposure at 2400°F. A 30 min exposure resulted in an increase in hardness and brittle fracture for both alloys. The WC3015 alloy oxidized in a parabolic manner at 2400°F. V.H. 112-coated WC3015 with a 0.004 by 0.25 in. coating defect exhibited significantly superior oxidation resistance, in perpendicular direction to its thickness, than V.H. 109 coated Cb752 or C 129Y with an identical coating defect. (G.M.C.)

45001 STUDY OF ANODIC OXIDATION OF ZIRCONIUM, TANTALUM, TITANIUM, AND ALUMINUM. Tomashov, N. D.; Zalivalov, F. P. J. Appl. Chem. USSR (Engl. Transl.); 43: No. 11, 2500–4(Nov 1970).

Translated from Zh. Prikl. Khim.; 43: No. 11, 2474–9(Nov 1970).

Study of variations of the voltage across the cell in anodic oxidation of tantalum, zirconium, titanium, and aluminum in acid solutions (tartaric, sulfuric, phosphoric, and oxalic) and of caustic potash at current densities of 1.5 and 7.5 mA/cm^2 and a final cell voltage of 130 V showed that, dependent on the metal and anodizing conditions, four types of anodic process are possible, characterized by the following variations of cell voltage: rapid linear increase (unlimited in the range studied), corresponding to formation of thin continuous films of high electrical resistance; voltage increase which ceases or slows down as the result of electrical breakdown and local destruction of the film; stabilization of the voltage after an initial increase to a certain value, which characterizes normal anodizing; finally, almost entire absence of voltage increase, corresponding to evolution of oxygen or anodic dissolution of the metal. Peculiar crater-shaped pores, which lower the resistance of the anodic film, are formed in the film as the result of electrical breakdown during the anodizing process. Chloride ions differ in their effects on anodizing of different metals; they have no influence on tantalum and titanium, their effect on zirconium depends on their concentration, and they have a very adverse effect on formation of an oxide film on aluminum, causing pitting of the metal surface. (auth)

45002 SODIUM CORROSION OF SNR STEEL CANS. Wieling, N. (Siemens AG, Erlangen, Ger.). Atomwirt, Atomtech.; 16: 80–1(Feb 1971). (In German).

Various types of steel were tested in the high-temperature loop of the Austrian Research Society for Atomic Energy. Sodium velocity was 2.7 m/sec and 5.4 m/sec, respectively. The loop temperature was 730°C; duration of the experiment was 1500 hours. Essential findings were as follows: sodium velocity had no significant effect on corrosion; corrosion occurred mainly on grain boundaries; all steels lost nickel and chromium from their boundary layers; diffusion of sodium into the steel could not be demonstrated. Also studied was the behavior of carbon and boron. (H.B.G.)

45003 ELECTROCHEMICAL BEHAVIOR OF A NIOBIUM OXIDE FILM IN ACETIC ANHYDRIDE SOLUTIONS. Egorov, V. V.; Lukovtsev, P. D. (Inst. of Electrochemistry, Moscow). Electrokhimiya; 6: No. 12, 1875-9(Dec 1970). (In Russian).

The properties of a niobium oxide film during its formation and alternating polarization were studied in relation to the concentration of protons in the electrolyte. The formation of an oxide film occurs under galvanostatic conditions. Various concentrations of water in acetic anhydride served as the electrolyte, the molarity of the water varying from 0.5 to 7.0, and these mixtures were saturated with sodium acetate in order to increase their electrical conductivity. A current density of 0.34 mA/cm^2 was maintained during oxide film formation; when the latter reached a thickness of 1,000 Å, the voltage was 40 V. The film so generated by a one-hour operation was subjected to an alternating polarity at a current density of 0.04 mA/cm^2, and a frequency which varied from 300 to 1,000 Hz. (tr-auth)

45004 HIGH TEMPERATURE COATINGS FOR REFRACTORY METALS AND THEIR ALLOYS. Subba Rao, B. V. S.; Tamhankar, R. V. (Defence Metallurgical Research Lab., Hyderabad, India). pp 94-138 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

High-temperature coating materials for Mo, Nb, W, Ta, and their alloys are reviewed. The basic factors associated with chemical, mechanical, and thermal stability are examined. (J.R.D.)

45005 DEVELOPMENTS IN OXIDATION AND CORROSION-RESISTANT MATERIALS. Elayathu, N. S. D.; Balachandra, J. (Bhabha Atomic Research Centre, Bombay). pp 96-118 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

The dominant role oxidation and corrosion play in the development and selection of materials for aerospace, atomic energy, desalination, and allied engineering fields is reviewed. It is shown that the selection of a material is based on a compromise of several factors and the best selection can be made as a result of close understanding among the design engineer, the metallurgist, and the manufacturer. (auth)

Preparation and Fabrication

Refer also to abstract 44557.

45006 (AERE-M-2301) EVALUATION OF FRICTION-WELDED JOINTS USED IN A PRESSURE VESSEL APPROVED BY LLOYD'S REGISTER INDUSTRIAL SERVICES. Child, J. B. (Atomic Energy Research Establishment, Harwell (England)). Apr 1971. 14p. Dep. NTIS (U. S. Sales Only). UK 20p.

An account of the tests made to obtain Lloyd's approval for the use of transition pieces 37.5 mm OD 30.5 mm ID with friction-welded joints between BS 970 En 58F stainless steel and BS 1476-1B aluminum in a pressure vessel designed for 350 lb/in.^{2} g at 100°C is given. (auth) (UK)

45007 (CONF-701211-1) DEVELOPMENT OF LARGE UNITS SUBJECTED TO INTERNAL PRESSURE. Carnoy, C. (Societe Babcock-Atlantique, Paris (France)). 1970. 10p. (In French). Dep. NTIS (U. S. Sales Only).

From Panel on the permanence of mechanics in advanced techniques; Paris, France (3 Dec 1970).

Recent techniques used for the construction and testing of large pressurized units (nuclear reactor vessels in particular) are described. These systems consist of a cylinder closed by fixed bases or bolted lids. The manufacture of the elementary vessels and the various types of welds used are presented. The methods used to detect defects either on the surface (magnetoscopy, sweating) or in depth (radiography, ultrasonics) are given. (France)

45008 (EUR-4348) ZIRCALOY-2-ZIRCALOY-2 AND ZIRCALOY-2-STAINLESS STEEL JOINTS (MAY 1, 1965-JULY 31, 1966). Volta, G.; Perona, G.; Brutto, E.; Barbesino, F.; Sesini, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1970. 80p. Dep. NTIS (U. S. Sales Only).

Laboratory scale experiments to obtain tubular tapered joints of Zircaloy-2 and AISI-304L stainless steel are described. Once swaging is over, the Zircaloy-2 tube inner diameter is to remain unvaried and the tube thickness reduction is to be as small as possible. Specimens of the first series of such joints have been submitted to metallographic observation and bend, burst, corrosion and pickup tests. The possibility of swaging steel pieces on Zircaloy-2 long tubes was also studied. Power measurements and equipment are described, which had been performed on the 44 V-type swaging-machine used for swaging of joints. Other parameters concerning the swaging machine and process were investigated with the aim of producing ORGEL joints. Junctions on different materials are dealt with as well as calculations and economic evaluations on Zircaloy stainless steel joints. Studies of the parameters of the swaging process as effected by plastic deformation are reported. Results of an analysis of the diffusion layer by microprobe, statistical studies on bonding brittleness, and additional studies are included. (auth)

45009 (EUR-4351) ZIRCALOY-2/ZIRCALOY-2 AND ZIRCALOY-2/STAINLESS STEEL JOINTS. Volta, G.; Perona, G.; Brutto, E.; Barbesino, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1970. 72p. NTIS (U. S. Sales Only).

Modifications and installations of the 417-type swaging-machine, used for Zircaloy-stainless steel joints of the ORGEL reactor (92 × 98 mm diameter) were investigated. The development stages of experiments on such junctions are described including description of operating parameters, production of joints having thickness and diameters close to their original values, and overlapped zone profile modifications to prevent stainless steel-stainless steel bonding between external container and joint piece. Experiments are also described which led to elimination of the external container. A chapter is devoted to experiments carried out on the 339-type swaging-machine (small diameter joints in support to those performed on 92 × 98 mm diameter tubes). ORGEL tubes were submitted to destructive testings by ultra-sounds, thermal and pressure cycle tests, and to indicative tests such as acoustic, torsion, 180° bending, and shear tests. An economic estimate of the unitary cost of produced joints was performed and possibilities of further developments were studied. Additional studies have been performed both on recovery of initial morphology of Zircaloy-2 anomalous stocks and residual stresses. (auth)

45010 (IAEA-117) DEVELOPMENT OF ADVANCED REACTOR PRESSURE VESSEL MATERIALS. Report of a Meeting, Tokyo, 21-25 July 1969. (International Atomic Energy Agency, Vienna (Austria)). 1970. v.p. (CONF-690727). INIS.

Abstracts of sixteen papers from the meeting were previously presented in NSA. For abstracts of individual papers see: 25: 37983; 39142; 39143; 40003; 40014; 40015; 40062; 40063; 40064; 40065; 40066; 40067; 40068; 40069; 40070; 40071. (D.H.M.)

45011 (RDT-F-6-10-T) REPAIR OF MATERIALS BY WELDING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 4p. RSO.

This standard sets forth requirements to be met in the repair of materials by welding. It is intended to be applied with referencing standards for basic material product forms. The requirements contained herein are intended to comply with the rules of ASME Boiler and Pressure Vessel Code, Section III, "Nuclear Power Plant Components", by being identical with or more stringent than its requirements. (auth)

45012 (TID-25741) PREPARATION AND SOME PROPERTIES OF BERKELIUM METAL AND CALIFORNIUM DIOXIDE. Fahey, James Andrew (Tennessee Univ., Knoxville). Jun 1971. 119p. Dep. NTIS.

Thesis.

The first bulk (5 μg) samples of berkelium metal have been prepared by the reduction at ~1025°C of BkF_3 with lithium metal in a tantalum crucible system. The BkF_3 starting material was obtained by air ignition of individual resin beads to BkO_2 followed by treatment with a $H_{2(g)}$-$HF_{(g)}$ mixture at 600°C. All but one of the samples exhibited a face-centered cubic (fcc) phase with a lattice parameter of 4.997 ± 0.004 Å. In addition, several samples exhibited a double hexagonal close packed (dhcp) phase with lattice parameters of a_0 = 3.416 ± 0.003 Å and c_0 = 11.069 ± 0.007 Å. Results of data analyses indicate that the fcc phase occurs at higher temperature than the dhcp phase. Results of magnetic susceptibility studies show that the dhcp phase has more +4 character than the fcc phase, in agreement with calculated metallic radii of 1.70_4 Å (dhcp) and 1.76_7 Å (fcc). During the course of this work and in similar work with Am, Cm, and Cf it was found that under conditions suitable for the preparation of microgram quantities of these metals, the relative volatilities are given by Cm ≪ Bk < Am ≪ Cf. The melting point of Bk metal has been determined to be 986 ± 25°C (90% confidence). The preparation of CfO_2 is reported for the first time. Air ignited individual resin beads were converted to a diphasic product by exposure to molecular oxygen at 100 atm and 300°C for 100 hours. The major phase (face-centered cubic phase) is believed to be CfO_2. Evidence is presented indicating that the second phase was a sub-stoichiometric dioxide. The dioxide was black and exhibited a face-

XUM

centered cubic lattice parameter of 5.312 ± 0.005 Å. The lattice parameter for the dioxide falls on the smooth curve of the other actinide dioxide lattice parameters plotted against atomic number and extrapolated to californium. The stoichiometry of the sample was not directly determined but rather assumed to be approximately that of the dioxide on the basis of x-ray crystallographic results, by analogy to similar lanthanide and actinide oxide systems and considerations of the preparative chemistry employed. (auth)

45013 METAL DEFORMATION PROCESSES: FRICTION AND LUBRICATION. Schey, John A. (ed.). Monographs and Textbooks in Material Science. 1. New York; Marcel Dekker Inc. (1970). 821p. $26.50.

Information on friction effects, wear mechanisms, lubricants, lubrication processes, wire drawing, forging, and sheet metal working is presented. (J.R.D.)

45014 DAS SCHWEISSEN DER NICHTEISENMETALLE. (Welding of Non-Ferrous Metals). Gilde, Werner. Berlin; Veb Verlag Technik (1968). 414p. 40,- M.

Aspects of welding of nonferrous material are discussed from the standpoint of construction, technology, metallurgy, and quality testing. Welding procedures are outlined and descriptions are given on equipment, and storage and transportation of semi-finished products. The analysis includes aluminum, beryllium, lead, gold, iridium, cadmium, copper, magnesium, molybdenum, nickel, niobium, platinum, silver, tantalum, titanium, uranium, tungsten, zinc, tin, and zirconium. Various alloys of these metals also are discussed. Information is included on resistance welding of material with non-ferrous plating. (H.B.G.)

45015 PREPARATION OF POLISHED SURFACES FOR THE METALLOGRAPHIC MEASUREMENT OF THE THICKNESS OF OXIDE LAYERS ON ZIRCONIUM SPECIMENS. Grabner, Ernst (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Prakt. Metallog.; 8: No. 5, 314-16(May 1971). (In German and English).

The oxide layers are protected by electroplating a copper coating about 1 U thick on the specimens using a base layer of silver deposited on the specimen from silver nitrate. The specimen surface is then polished and etched using a water solution of lactic acid, nitric acid, and hydrofluoric acid. (J.R.D.)

45016 ACTIVITIES DEVELOPED IN ITALY IN THE NUCLEAR FUEL MANUFACTURING FIELD. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 63-77(Oct 1970). (In Italian). (CONF-700903-10).

From fourth Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden (21 Sep 1970).

The activities of the CNEN and industry in the production of nuclear fuels are summarized. The types of fuel elements being studied are metallic U clad with Mg alloy, slightly enriched U_3O_8 in the form of tablets encased in Zircaloy tubes, slightly enriched U_3O_8 in tablet form encased in stainless steel tubes, and natural uranium oxide in the form of large compacts encased with Zr alloys and assembled in rod clusters. (J.S.R.)

45017 ATLAS. TRANSFORMATION CHARACTERISTICS OF CHROMIUM AND CHROMIUM–MOLYBDENUM WHITE IRONS. EXPERIMENTAL PROCEDURE. Maratray, F.; Usseglio-Nanot, R. Paris; Climax Molybdenum S.A. (1970). 198p. (In several languages).

High-alloy white irons are assuming an ever greater importance in industry because of their excellent abrasion resistance. More information on their transformation characteristics has been needed, however, so compositions and treatments could be selected to give castings having optimum structures from the standpoint of abrasion resistance. An atlas is presented which contains data on 42 irons with systematically chosen compositions so as to indicate the effect of carbon, chromium, and molybdenum contents on transformation characteristics. A discussion of structure and certain relations between composition and transformation is given in the companion publication, Factors Affecting the Structure of Chromium and Chromium–Molybdenum White Irons. (auth)

45018 MANUFACTURE OF POWDERS OF TITANIUM ALLOYS AND TITANIUM-BASE REFRACTORY COMPOUNDS FROM TITANIUM ALLOY SCRAP. Rubtsov, A. N.; Olesov, Yu. G.; Ustinov, V. S.; (and others). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 969-73(Dec 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 18-23(Dec 1970).

Electrolytic titanium powders (99.75%) were prepared from titanium sponge scrap. It was established that electrolytic titanium powder is greatly superior in quality to calcium hydride-thermic titanium powder. A study was made of the preparation of titanium alloy powders (Ti–Al, Ti–Al–V, Ti–Mn, Ti–Zr) by the electrolytic refining of scrap of standard titanium alloys. The optimum conditions for the hydrogenation and subsequent dehydrogenation of VT5 and VT6 alloy scrap were established. Dehydrogenated VT5 and VT6 alloy powders were prepared approximating in chemical composition the starting alloys. The problems involved in the manufacture of hard titanium compounds from titanium scrap and primary titanium-containing materials were examined. (auth)

45019 ELECTROTHERMIC PRODUCTION OF MOLYBDENUM POWDER WITH PARTICLES OF LAMELLAR SHAPE. Trotsenko, V. I.; Loshkarev, Yu. M.; Chelpanov, I. P. (Dnepropetrovsk State Univ., USSR). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 958-61(Dec 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 5-9(Dec 1970).

The results are presented of an investigation into the conditions of formation of molybdenum powder during electrothermic reduction. It is shown that high-purity molybdenum powder with a lamellar particle structure can be produced by the electrolysis of aqueous molybdate solutions using a mercury cathode, followed by the reduction annealing of the resulting cathodic deposit in a hydrogen atmosphere. (auth)

45020 METHOD OF CASEHARDENING VANADIUM AND VANADIUM ALLOYS. Zic, John A.; Hill, George F.; Mayfield, Ross M. (to United States Atomic Energy Commission). U. S. Patent 3,577,283. 4 May 1971. Filed 7 Mar 1969.

A method of case hardening vanadium and vanadium alloys consisting predominantly of vanadium by heating the material briefly at 1100 to 1300°C in an atmosphere of argon saturated with water vapor is described. (Official Gazette)

45021 PROCESS OF COATING WITH TITANIUM, HAFNIUM, ZIRCONIUM, AND URANIUM. Karlak, Robert Francis (to Lockheed Aircraft Corp.). British Patent 1,197,514. 8 Jul 1970. Filed 25 Aug 1967.

A process for forming a metal coating on the surface of an article is described. A metallizing mixture is applied to the surface of the article and then heated to a predetermined temperature in a nonoxidizing atmosphere for a time sufficient to melt the salts in the metallizing coating and deposit a coating of metal on the surface of the article. The metal coating consists of a thin transition layer and a second porous layer bonded to the first layer. (auth)

45022 MANUFACTURING OF VAPOR DEPOSITED REFRACTORY MATERIALS. Lorel, Roland (Societe Generale du Vide, Paris). Entropie; No. 36, 32-44(Nov-Dec 1970). (In French).

The technique of chemical deposition in gaseous phase was employed to obtain several refractory metals and their carbides on various substrates. High-purity Mo, W, Nb, Ta, Ti, Zr, Si coatings were obtained by hydrogen reduction or by thermal dissociation of their chlorides. Direct production of the carbide from a gaseous mixture of the metal halogenide, methane, and hydrogen was chosen, giving the highest deposition rate and yielding the purest deposits. A detailed theoretical analysis is presented, attempting to correlate deposition rates (diffusion process) with the parameters of the ternary systems. The experimental part includes the description of the apparatus; mechanical, physical, and thermal properties of the coatings; analysis of the influence of substrate temperature, total and partial pressures in the gas-phase upon morphology variations of the deposit. An original method to produce W (110) coatings in the case of thermionic conversion emitters is described. (auth) (France)

45023 RECENT ADVANCES IN PREPAINTED METAL. I. ELECTRON BEAM CURING OF COATINGS. Winchcombe, P. D.; Roberts, M. L. (British Steel Corp., Port Talbot, Wales). Trans. Inst. Metal Finish.; 49: 36-8(Spring 1971).

Advances in the prepaint industry have necessitated the development of different curing techniques not hitherto commonly associated with prepaint technology. Theoretical and technical aspects of electron beam curing are discussed with a view to showing that the process may be commercially viable. (auth) (UK)

45024 SCHWEISSEN VON DRUCKBEHAELTERN FUER KERNKRAFTANLAGEN. (Welding of Pressure Vessels for Nuclear Power Plants). DVS 3002 1967. Krefeld, Ger.; Deutscher Verband fuer Schweisstechnik e.V. (1967). 4p. Available from Deutscher Verband fuer Schweisstechnik e.V. Krefeld, Ger.

The standard concerns reactor pressure vessels of metallic structure for nuclear power installations. Strict technical safety requirements and aspects of economical performance are considered. In accordance with this standard, all other pressure vessels for nuclear power plants can also be welded. Standards

are given for the preparation phase, the welding process, and test procedures. (H.B.G.)

45025 SCHWEISSEN VON SICHERHEITSBEHAELTERN FUER KERNKRAFTANLAGEN. (Welding of Safety Vessels for Nuclear Power Plants). DVS 3001 1967. Krefeld, Ger.; Deutscher Verband fuer Schweisstechnik e.V. (1967). 4p. Available from Deutscher Verband fuer Schweisstechnik e.V., Krefeld, Ger.

The standard concerns steel safety vessels for nuclear power plants. In case of a reactor incident, the vessels must withstand pressure elevations and must prevent escape of radioactive material, or must keep radioactive emission within permissible levels. The instruction is also applicable to locks and similar installations. Standards are given for the preparation phase, the welding process, and test procedures. (H.B.G.)

45026 SCHWEISSEN VON ROHRLEITUNGEN FUER KERNKRAFTANLAGEN. (Welding of Piping for Nuclear Power Plants). DVS 3003 1969. Krefeld, Ger.; Deutscher Verband fuer Schweisstechnik e.V. (1969). 3p. Available from Deutscher Verband fuer Schweisstechnik e.V., Krefeld, Ger.

The standard concerns the welding of metal piping in nuclear power plants. Certain systems of nuclear power plants require special instructions for the quality of welding connections which deviate from those already in existence for the welding of pipes subjected to internal pressure. Standards are given for the preparation phase, the welding process, and test procedures. (H.B.G.)

45027 LOW-TEMPERATURE SINTERED TUNGSTEN AND ITS APPLICATION. Ito, Hiroshi (Nippon Tungsten Co. Ltd., Fukuoka). Funtai Oyobi Funmatsuyakin; 17: No. 4, 143-54 (Nov 1970). (In Japanese).

Low-temperature sintering of tungsten has been done by addition of nickel or palladium. A series of experiments was carried out by addition of nickel–phosphorus alloy in order to promote low-temperature sintering of tungsten. It was found that by use of this method high-density sintered tungsten can be produced at lower temperatures and in less time, compared with the method in which nickel is used. The addition of nickel–phosphorus alloy promotes the low-temperature sintering of tungsten by forming a liquid phase at sintering temperature; the nickel–phosphorus alloy which formed the liquid phase, wets tungsten; and the diffusion rate between the tungsten and nickel–phosphorus alloy is high. Several industrial applications of this method with the nickel–phosphorus alloy are described. (Japan)

45028 CONTRIBUTION OF POWER METALLURGY TECHNIQUES TO MATERIALS SCIENCE. Reshamwala, A. S.; Tendolkar, G. S. (Indian Inst. of Tech., Bombay). pp 163-87 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Special methods of producing metal powders are described along with methods of powder consolidation. Discussions are included on aspects of material selection and processing for powder metallurgy product fabrication. It appears that compaction techniques such as high velocity impaction, cyclic compression, and powder rolling hold out great possibilities. Powder rolling has increasingly been adopted commercially for the production of strips. Recent advances in techniques such as spark sintering, promise economic advantages by reducing sintering time and doing away with relatively costly protective atmospheres. It also appears that activated sintering could be one of the methods of improving those properties which are sensitive to pore geometry. (J.R.D.)

Properties Evaluations

Refer also to abstracts 44484, 45145, 45602, 45604, and 45605.

45029 (BMI-1908) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Final Report, Task 17. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle memorial Inst., Columbus, Ohio). Jun 1971. Contract W-7405-eng-92. 60p. Dep. NTIS.

The results of 34 experiments on representative reactor piping materials (A106B carbon steel and Type 316 stainless steel) have provided information on the axial and circumferential flaw sizes that are required to initiate fractures in water-reactor primary coolant piping under operating conditions. Analytical expressions have been shown to be capable of predicting critical axial through-wall and surface flaw sizes. For the tough structural-type materials used in reactors, which operate at relatively high temperatures, it is possible to predict critical flaw sizes based on tensile test properties at temperature and the dimensions of the piping using a plastic instability type of approach. The results of experiments with circumferential surface flaws have indicated long surface flaws are required to produce critical flaw sizes under operating conditions. The circumferential surface flaws required to produce a rupture at a given stress level are significantly longer than those required for an axial surface flaw of the same depth. A concept for the prediction of critical circumferential flaw sizes based on a plastic instability type of approach has been formulated. The results appear to be in agreement with the experimental data. The formulation incorporates the bending moment that is developed by the circumferential flaw as a result of the nonsymmetrical cross section at the flaw. The axial propagation of flaws was thought to be controlled by the saturation pressure hoop stress level, based on the results of the first phase of this program. However, the results of the second phase have shown that even though the stress level is below a threshold stress for axial extension of a propagating shear fracture, a tearing shear fracture can still spiral around the pipe when large amounts of stored energy are available in the system. The tearing shear fracture, because it apparently can extend at low stress levels, eliminates the possibility of controlling fracture extension in reactor piping by controlling the saturation pressure stress level as suggested in the Phase I results. (auth)

45030 (NYO-3756-6) CHEMICAL AND PHYSICAL CHARACTERISTICS OF EXPLODING WIRE PRODUCTS. Russell, Irving J.; Driscoll, Joseph R. (Boston Coll., Chestnut Hill, Mass. Dept. of Chemistry). Jun 1971. Contract AT(30-1)-3756. 59p. Dep. NTIS.

Experiments aimed at reproducing phenomena associated with generation of radioactive particles in nuclear explosions are described. Iron and other refractory wires were used. It was found that the refractory elements have their highest concentration in the large particle size fractions, stages 1, 2, or sometimes 3. Correspondingly the volatile class of elements is found enriched in stage 5 which contains the sub-micron entities having a median mass diameter of 50 to 60 millimicrons. In the refractory class are Zr, Y, Pr, Nd, La, Ce and Mo and Ru in part in air explosions. In argon explosions Mo and Ru behave precisley like Zr. The volatile group includes In, Sn, Sb, Te, I and Se. Sr, Ce and Ba form an intermediate volatility group, in that order. Fe and Co tracers behave identically in the pair of experiments they were observed together, and their distribution follows the trends recorded in mixing experiments. The relative behavior of most elements is little affected by whether the explosion took place in air or argon, with the exception of Mo and Ru. This also is in accord with Bedford and Jackson's calculations. (J.R.D.)

45031 (ORNL-TM-3321) THERMAL STABILITY OF TITANIUM-MODIFIED HASTELLOY N AT 650 AND 760°C. Sessions, C. E.; Stansbury, E. E. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 43p. Dep. NTIS.

The influence of small titanium additions on the thermal stability of Ni–12% Mo–7% Cr–0.07% C was investigated. The mechanical properties at 650°C (tensile tests at 0.002/min strain rate and creep tests at 40,000 psi stress) were measured for four heats of this alloy with titanium contents from 0.15 to 1.2%. Solution annealing temperatures were 1177 or 1260°C, and subsequent precipitation heat treatments were conducted at 650 and 760°C. Titanium increases the stability of a complex MC-type carbide. At low titanium levels the MC carbide is stable at 650°C but is unstable at 760°C, where an M_2C-type carbide is precipitated, resulting in inferior properties. For the higher titanium concentrations the MC carbide is stable on aging at 760°C and results in excellent properties after a solution anneal at 1177°C. However, high-titanium alloys are significantly less ductile if they are solution annealed at 1260°C and aged at either 650 or 760°C. The heat with the lowest carbon content (0.04% C) was most resistant to property changes on aging up to 10,000 hr at both 650 and 760°C. (auth)

45032 LOAD-BEARING CAPACITY OF WELDING CONSTRUCTIONS IN PRESSURE VESSEL AND PIPING FABRICATION WITH PARTICULAR CONSIDERATION TO FAILURES IN THE WELDED JOINTS. Kussmaul, K. (Univ., Stuttgart). Schweissen Schneiden; 22: No. 12, 509-14(1970). (In German).

Cases of failure in vessels and cylinders are reviewed. Although only conventional engineering techniques are discussed, their applicability to the field of nuclear engineering is evident. The investigations are concerned with the static stress in pressure vessels of a more extensive wall thickness, in branch pieces and in thin-walled large size tubes and the results are represented by a failure analysis. Based on these investigations, the requirements for materials, manufacturing, and testing are briefly explained. (INIS)

45033 URANIUM MARKET. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 58-9(Oct 1970). (In Italian). (CONF-700903-8).

XUM

From fourth Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden (21 Sep 1970).

The availability of uranium to the Italian nuclear energy program and the short-term utilization of Pu are briefly discussed. The uranium reserves in Italy are evaluated. (J.S.R.)

45034 CONTACT INTERACTION OF TITANIUM CARBIDE WITH TITANIUM, ZIRCONIUM, AND VANADIUM IN A VACUUM. Strashinskaya, L. V. (Inst. of Material Working, Kiev). Fiz.-Khim. Mekh. Mater.; 7: No. 1, 86-8(1971). (In Russian).

High-temperature, solid-phase reactions were studied at surface contact between TiC and three different metals by examining the microstructure for evidence of a diffusion layer 1 to 2 μ thick, or detecting new lines in the x-ray diffraction pattern, evidencing a new phase. With TiC–Ti at 1100 to 1650°C the lattice parameters were seen to shrink perceptibly. With TiC–Zr at 1200 to 1500°C, ZrC was formed in a few hours to a depth of 9 μ. In the case of TiC–V at 1600 to 1650°C, V_2C formed in one hour, and VC in 3 hr. (K.S.W.)

45035 REGION OF APPLICABILITY OF HENRY'S LAW AND SIEVERT'S LAW FOR SOLUTIONS Nb–O AND Nb–N. Dushin, Yu. A.; Mikhailov, S. K. Fiz.-Khim. Mekh. Mater.; 7: No. 1, 91-2(1971). (In Russian).

Of four mechanisms of gas-solid interaction, it is suggested that the dissolution rate and rate of separation are greater than the rates of sorption and desorption. A mathematical relation is derived which represents the kinetic interpretation of Henry's and Sievert's laws, each law applying to two of the four mechanisms. At low regions of the gas system the solution obeys Henry's law, at upper-Sievert's. In the interval 1500 to 2500°K the equilibrium constant $K_{eq} = P_g^2/P_{g2}$ for O_2 is greater by 16 to 9 orders of magnitude than that for N_2, so that the probability of "atomic" behavior is undoubtedly greater for O_2. Thermodynamic limitations properly divide the areas of applicability of these laws which in turn describe how the gas concentration will vary in the solutions Nb–O and Nb–N at uninvestigated pressures and temperatures. (K.S.W.)

45036 ITALIAN PROGRAMS FOR PLUTONIUM UTILIZATION. Com. Naz. Energ. Nucl., Notiz.; 16: No. 10, 78-88(Oct 1970). (In Italian). (CONF-700903-11).

From fourth Foratom Congress on Industrial Aspects of the Nuclear Fuel Cycle in Europe, Stockholm, Sweden (21 Sep 1970).

The incentives for the utilization of Pu in power reactors are summarized. Pu availability and needs in the E.N.E.L. centers are evaluated. The C.N.E.N. and E.N.E.L. programs on the use of Pu are outlined. Economic consideration in the use of Pu in power reactors is discussed. The recycling duration for Pu is considered. (J.S.R.)

45037 EFFECT OF STRUCTURE AND TEST CONDITIONS ON THE MECHANICAL PROPERTIES OF LOW-ALLOY MOLYBDENUM. Danyushchenkov, I. A.; Ivashchenko, R. K.; Mil'man, Yu. V.; Trefilov, V. I.; Iakushina, A. I. (Inst. of Metal Physics, Kiev). Probl. Prochnosti; 2: 58-63(Dec 1970). (In Russian).

A correlation was established between the mechanical characteristics obtained during tensile and bending tests of brand TZM-2A sheet molybdenum with various structural states. It is shown that the ratio between these characteristics decreases somewhat with an increase in strain rate. The plasticity characteristics do not depend on the strain rate, if the test temperature is much greater than the brittle transition temperature, and sharply decrease with an increase in strain rate, if the test temperature is close to the brittle transition temperature. (IAA)

45038 FUEL ELEMENT DEFORMATION MODEL FOR FAST REACTOR ACCIDENT STUDY CODE. Youngdahl, Carl K. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 15: No. 2, 149-86(1971).

The Fuel Deformation Program, DEFORM, in the Fast Reactor Accident Study Code, SAS1A, is described. The program is used to compute the elastic deformation of the fuel and the elastic-plastic deformation of the cladding during a temperature transient. The fuel element is divided into axial segments; the primary plane thermal deformation of each segment is calculated and then corrected for the effect of shear stresses produced by the axial and radial temperature gradients. Fuel melting along the rod centerline is taken into account, and variations in the fuel-clad gap are computed. (auth)

45039 CLASSIFICATION OF BINARY EUTECTICS. Taylor, M. R. (Univ. of Birmingham, Eng.); Fidler, R. S.; Smith, R. W. Met. Trans.; 2: No. 7, 1793-8(Jul 1971).

Values of the interface roughness parameter (α) were calculated for the primary phases of the 12 simple binary eutectic systems for which sufficient thermodynamic data are available; namely, Ag–Bi, Ag–Cu, Ag–Pb, Al–Ge, Al–Sn, Bi–Cd, Bi–Sn, Cd–Pb, Cd–Zn, In–Zn, Pb–Sb, and Sn–Zn. It is shown that in the presence of solute the values of α can be significantly different from those of the pure component elements. The calculated values of α are correlated with eutectic morphologies on the basis of the Hunt and Jackson classification. If the broken lamellar structure is also in the faceted/nonfaceted group, then the results are in agreement with Hunt and Jackson's classification. The analysis is discussed in the light of recent interpretations of the theories of solid–liquid interfaces and resultant growth morphologies. It is concluded that thermodynamic calculations are useful in the prediction of eutectic structures even though they may not necessarily resolve arguments concerning the mechanisms of eutectic solidification. (auth)

45040 ANALYSIS OF INTERDIFFUSION IN FINITE-GEOMETRY, TWO-PHASE DIFFUSION COUPLES IN THE Ni–W AND Ag–Cu SYSTEMS. Tanzilli, R. A.; Heckel, R. W. (Drexel Univ., Philadelphia). Met. Trans.; 2: No. 7, 1779-84(Jul 1971).

The progress of homogenization in finite, multilayer diffusion couples was studied experimentally using both quantitative metallography to measure phase thicknesses and electron microprobe analysis to determine concentration-distance profiles. Ni–W couples having mean compositions in the nickel-rich terminal solid solution range (12.1 and 15.2 at. % W) were studied after 4.43 to 240.7 hr interdiffusion treatments at 1156 and 1207°C. Ag–Cu couples having mean compositions in both of the terminal solid solution ranges (8.5 at. % Cu and 2.1 at. % Ag) were studied after 3.8 to 65.4 hr interdiffusion treatments at 760°C. Experimental data were in good agreement with calculations of interdiffusion based on equilibrium interface concentrations and concentration-independent interdiffusion coefficients. The good agreement between experimental data and calculated values for the Ni–W couples extended to times necessary for the achievement of essentially complete homogenization, i.e., through both the two-phase dissolution process and the subsequent stage of gradient elimination in the terminal solid solution phase. (auth)

45041 THERMODYNAMICS OF YTTERBIUM–ALUMINUM ALLOYS. Kulifeev, V. K.; Stanolevich, G. P.; Kozlov, V. G. (Moscow Inst. of Steel and Its Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 146-8(1971). (In Russian).

In the aluminothermic reduction of Yb_2O_3 the product metal is usually contaminated with aluminum. An effort was made in this work to refine the Yb metal. By the loss-in-weight method the vapor pressure of Yb was found to obey the relationship: $\log P = 8.0532 - 7416.5/T$ mm Hg from 410 to 550°C. The heat of sublimation over this interval was 33.16 kcal/g. Deviations of Yb–Al mixtures from Raoult's law, however, pointed to the presence of weakly dissociated intermetallic compounds $YbAl_2$ and $YbAl_3$. Anomalous activity curves for Yb–Al alloys indicated that vacuum purification of Yb in such binary mixtures would be effective up to a Yb content of 67 atomic % Yb. (K.S.W.)

45042 COBALT-BASE ALLOYS FOR USE IN NUCLEAR REACTORS. Fleitman, A. H.; Herchenroeder, R. B.; Chow, J. G. Y. (Brookhaven National Lab., Upton, N. Y.). Nucl. Eng. Des.; 15: No. 4, 345-62(May 1971).

Properties of Co and Co alloys for use in reactors are reviewed. Information is included on metallurgy of Co-base alloys, effects of heat treatment, preparation and fabrication, radiation damage, and sources of Co. (J.R.D.)

45043 LEAD, BISMUTH, TIN, AND THEIR ALLOYS AS NUCLEAR COOLANTS. Weeks, J. R. (Brookhaven National Lab., Upton, N. Y.). Nucl. Eng. Des.; 15: No. 4, 363-72(May 1971).

Properties of Bi, Pb, and Sn and their alloys for use as reactor coolants are reviewed. Information is included concerning corrosive effects of these materials, on metals and ceramics and on the use of corrosion inhibitors. (J.R.D.)

45044 PLUTONIUM AND PLUTONIUM ALLOYS AS NUCLEAR FUEL MATERIALS. Kittel, J. H. (Argonne National Lab., Ill.); Ayer, J. E.; Beck, W. N.; (and others). Nucl. Eng. Des.; 15: No. 4, 373-440(May 1971).

A summary on the technology of Pu and its alloys is presented. Information is included on phase relations, physical properties, mechanical properties, preparation, fabrication, and compatibility behavior. (J.R.D.)

45045 EFFECT OF HEATING RATE IN THERMOELASTIC STRESS PRODUCTION. Gauster, W. B. (Sandia Labs., Albuquerque, N. Mex.). J. Mech. Phys. Solids; 19: No. 3, 137-45 (Jun 1971).

Using pulses of monochromatic MeV electrons from a linear accelerator to heat copper and tantalum samples, measurements of

thermoelastic stresses were made as a function of heating rate. The results were compared with the predictions of thermoelastic wave theory, and good agreement was found. (auth) (UK)

45046 SPECIAL FEATURES OF THE MECHANISM OF PLASTIC DEFORMATION OF NIOBIUM. Mil'man, Yu. V.; Trefilov, V. I.; Udovenko, A. A. (Inst. of Metal Physics, Kiev). Probl. Prochnosti; 2: 45-50(Dec 1970). (In Russian).

The changes in the dislocation structure and mechanical properties of polycrystalline niobium as a result of plastic deformation and annealing were studied. The differences in the mechanism of plastic deformation of niobium as against the corresponding mechanisms in the case of molybdenum and other bcc metals of Group VIA are shown to be related to the lower rigidity of the interatomic bond in the case of niobium and the higher value of the activation volume. (IAA)

45047 INTERACTION OF CERTAIN TRANSITION METALS WITH A SODIUM SILICATE MELT. Ban'kovskaya, I. B. (Inst. of Silicate Chemistry, Moscow). J. Appl. Chem. USSR (Engl. Transl.); 43: No. 12, 2639-43(Dec 1970).

Translated from Zh. Prikl. Khim.; 43: No. 12, 2597-2601(Dec 1970).

The gases evolved when iron, niobium, chromium, titanium, zirconium, nickel, and molybdenum are immersed in a silicate melt contain nitrogen, oxygen, carbon monoxide, and hydrogen. The rate of gas evolution increases with the corrosion losses of various metals. The products of metal corrosion formed in a silicate melt include silicides in addition to oxides. (auth)

45048 SPECIFIC ELECTRICAL RESISTANCE OF SOME LIQUID TERNARY ALLOYS OF THE INDIUM–TIN–BISMUTH SYSTEM. Tschirner, H. U.; Wobst, M. (Technische Hochschule, Karl-Marx Stadt, Ger.). J. Less-Common Metals; 24: 103-5(May 1971). (In German).

The specific electrical resistance of 55 melted In–Sn–Bi alloys was measured with a rotating field and without electrodes. Results showed that the liquid alloys represent systems of solutions. (H.B.G.)

45049 THERMAL EXPANSION OF TUNGSTEN AT LOW TEMPERATURES. Shah, Jayant S.; Straumanis, M. E. (Univ. of Missouri, Rolla). J. Appl. Phys.; 42: No. 9, 3288-9(Aug 1971).

Lattice parameters, thermal expansion coefficients, and Grueneisen parameters of tungsten are determined by an x-ray method in the temperature range of 180 to 40°K without the use of liquid gases. Lattice parameters are expressed as a function of temperature. Thermal-expansion coefficients decrease with temperature and show no anomaly in contrast to a hypothesis proposed by Featherston and Neighbours. Grueneisen parameters γ decrease with temperature in accordance with theoretical predictions. (auth)

45050 ELASTIC MODULI AND THERMAL EXPANSION OF LUTETIUM SINGLE CRYSTALS FROM 4.2 TO 300°K. Tonnies, J. J.; Gschneidner, K. A. Jr.; Spedding, F. H. (Iowa State Univ., Ames). J. Appl. Phys.; 42: No. 9, 3275-83(Aug 1971).

The adiabatic elastic moduli of hexagonal close-packed lutetium single crystals were determined by the ultrasonic pulse superposition technique over the temperature range 4.2 to 300°K. The values at 300°K in units of 10^{11} dyn/cm^2 are $C_{11} = 8.62$, $C_{33} = 8.09$, $C_{44} = 2.68$, $C_{66} = 2.71$, and $C_{13} = 2.8$; the values extrapolated to 0°K are $C_{11} = 9.10$, $C_{33} = 8.40$, $C_{44} = 2.91$, $C_{66} = 2.96$, and $C_{13} = 2.9$. The Debye temperature calculated using the elastic moduli at 0°K is 184.5°K. The bulk elastic properties were also calculated, and they agree favorably with previously predicted polycrystalline values. The linear thermal-expansion coefficients of the lutetium single crystals were determined over the same temperature range by using a linear-variable-differential-transformer dilatometer. The room-temperature coefficients of thermal expansion are $\alpha_{\parallel} = 20.0 \times 10^{-6}$ and $\alpha_{\perp} = 4.82 \times 10^{-6}$°K^{-1}. A maximum in $\alpha_{\perp}$ was found at 130°K, which apparently correlates with the maximum found in the $\gamma_{\perp}/\gamma_{\parallel}$ ratio at 130°K, where γ is the Grueneisen constant. (auth)

45051 BINDING STATES OF HYDROGEN ON TUNGSTEN. Tamm, P. W.; Schmidt, L. D. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 54: No. 11, 4775-87(1 Jun 1971).

The binding states, adsorbate densities, and desorption kinetics of hydrogen on the (110), (111), and (100) crystal planes of tungsten are examined. There are two atomic states on the (110) plane and four atomic states on the (111) plane. Saturation hydrogen densities are approximately equal in the major states on both planes and correspond to one hydrogen atom for each surface tungsten atom on the (110) plane and approximately four hydrogen atoms for each surface tungsten atom on the (111) plane. While the desorption activation energies of the most tightly bound states on all three planes are nearly identical, there are weakly bound (E_d = 14 and 22 kcal mole^{-1}) atomic states on the (111) plane which are entirely lacking on the other planes. These results show that there are considerable variations in hydrogen adsorption on these planes. Arguments are advanced that the surface atom configurations are nearly those of the bulk crystal, and hydrogen surface structures are proposed to account for the observed binding states. Some qualitative aspects of the adsorption bonds are also considered. (auth)

45052 HEAT CAPACITY OF SCANDIUM FROM 6 TO 350°K. Gerstein, B. C.; Taylor, W. A.; Schickell, W. D.; Spedding, F. H. (Iowa State Univ., Ames). J. Chem. Phys.; 54: No. 11, 4723-8 (1 Jun 1971).

The heat capacity of scandium has been measured from 6 to 350°K. The results differ from previous measurements in this temperature range by more than the accuracies of the measurements. The difference is discussed in terms of impurity effects. The following values are obtained for the thermodynamic functions at 298.15°K: $C_p^0 = 25.51 \pm 0.05$, $S^0_{298.15} = 34.78 \pm 0.20$, $(H^0_{298.15} - H^0_0)/T = 17.46 \pm 0.10$, and $-(G^0_{298.15} - H^0_0)/T = 17.31 \pm 0.14$, all in joules per mole per degree Kelvin. (auth)

45053 INTERACTIONS BETWEEN CHEMISORBED SPECIES: H_2 AND CO ON (100) TUNGSTEN. Yates, John T. Jr.; Madey, Theodore E. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 54: No. 12, 4969-78(15 Jun 1971).

The interaction of CO with chemisorbed β-hydrogen on the (100) plane of tungsten was investigated using flash desorption and work function methods. CO efficiently displaces chemisorbed hydrogen from tungsten at temperatures near 300°K. This is a result of the CO-induced lowering of the activation energy for H_2 desorption, with the CO chemisorbing initially on sites other than those occupied by hydrogen. At ~100°K, little CO-induced displacement of chemisorbed hydrogen occurs, and the production of three weakly bound hydrogen states (designated ν-hydrogen) is observed. Each ν state exhibits a range of desorption energies. During the CO-induced surface conversion of β-hydrogen to ν-hydrogen, a decrease in work function is observed. All of this behavior is indicative of a major interaction between adsorbed CO and adsorbed hydrogen. A weakly bound molecular H_2 state (δ-hydrogen) may be populated by adsorption of H_2 on top of partial CO layers on W(100) at ~100°K. The sites adsorbing this molecular state of hydrogen are related to the presence of β-CO species, and are probably the same sites which could adsorb α-CO at higher CO coverages. In thermal desorption, the liberation of two discrete hydrogen binding states (β_1 and β_2) from pure hydrogen layers on W(100) is probably a result of coverage-dependent interactions between identical adsorbed H-atom species. No chemical differences are observed in this work between hydrogen species responsible for the two β-hydrogen binding states. No catalytic production of H_2CO, HCO, CH_4, or C_2H_6 was observed in coadsorption of hydrogen and CO on W(100). (auth)

45054 FIELD-EMISSION MICROSCOPY OF SOME ALLOYS IN THE LANTHANUM–TUNGSTEN SYSTEM. Palyukh, B. M.; Yakivchuk, A. I. (Lvov State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 149-52(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 189-94(Jan 1971).

The work function φ was measured for a tungsten point coated with lanthanum. The film system is found to have a minimum in φ, whose depth is dependent on the temperature of the point and the clearness of the surface. The activation energy Q_m for migration of lanthanum is examined as a function of degree of surface coating. (auth)

45055 NOVEL METHOD FOR THE DETERMINATION OF THE SOLUBILITIES OF SOLUTES IN LIQUID METALS. THE SOLUBILITY OF ANTIMONY IN SODIUM FROM 190 TO 550°C. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 40: No. 2, 195-204 (Aug 1971).

A method suitable for determining the solubility of a wide range of solutes in liquid metals is described. The method should be also suitable for studies of the solubilities of mixed solutes. The solubility of antimony in sodium is given by the expression $\log_{10} S_{Sb}$ ppM = $(8.662 \pm 0.007) - (3.943 \pm 0.023)/T$ between 190 and 550°C. The partial molal heat of solution of Na_3Sb in sodium is 75.48 ± 0.48 kJ/mole and the partial molal heat of solution of antimony in solution has been calculated to be -121.3 ± 25.5 kJ/mole. No diffusion of antimony into stainless steel was observed. Adsorption of antimony on stainless steel under liquid sodium was observed. The adsorption corresponded to a few percent of a monolayer at 250°C. (auth)

45056 HIGH TEMPERATURE MATERIALS. Madhav Rao, V. N.; Tamhankar, R. V. (Defence Metallurgical Research Lab., Hyderabad, India). pp 35-64 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

XUM

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

A review of high-temperature materials is presented. Materials for gas turbines used in aerospace development are emphasized. Information is included on Fe-, Co-, and Ni-base alloys. Information is also included on properties and uses of refractory alloys, cermets, and composites. (J.R.D.)

45057 APPLICATION OF LIGHT METALS IN DEFENCE. Ghude, S. H.; Reddy, T. Ranga; Tamhankar, R. V. (Defence Metallurgical Research Lab., Hyderabad, India). pp 65-93 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Application of light metals such as Al, Ti, Mg, and Be in defense materiel is discussed. Information is included to show that in spite of the challenge from plastic and ceramic composite materials, light metals and light metal alloys maintain their superior position in the manufacture of defense hardware. However, with developments of new light-weight metals such as titanium and beryllium, some changes in the spectrum of applications are likely. Until recently aluminum alloys were considered as the most indispensable material in the construction of airframes. With the development of higher speed aircraft, they are likely to yield this position to titanium alloys. However, aluminum alloys will continue to find new applications in tanks, armor, and missiles, because of their excellent combination of high specific strength, good corrosion resistance, and low cost. As more knowledge is acquired about the technology of titanium, it is likely to find new applications in missiles, spacecraft components, and armor. Beryllium alloys are likely to become keen competitors to titanium alloys in various applications. However, at present its applications are limited to spacecraft and rockets. (auth)

45058 PRINCIPLES OF DEVELOPMENT OF HIGH TEMPERATURE MATERIALS. Rodriguez, P. (Bhabha Atomic Research Centre, Bombay); Arunachalam, V. S. pp 186-201 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Principles involved in strengthening metals and alloys for use at high temperatures are reviewed. Information is included on requirements for high temperature materials, solid solution strengthening, dispersion hardening, and creep and fracture resistance. (J.R.D.)

45059 HIGH TEMPERATURE SUPER ALLOYS WITH PARTICULAR REFERENCE TO TITANIUM. Bhattacharjee, S. K. (Union Carbide (India) Ltd., Calcutta). pp 202-19 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

A review of the properties of superalloys and other high-temperature alloys is presented. Information is included on base metals for superalloys, and on properties of superalloys having Co, Ni, or Nb as their base. Information is also included on high temperature Ti-base alloys and on Zr-Al alloys. (J.R.D.)

45060 MATERIALS FOR REACTOR TECHNOLOGY. Rao, N. Kondal; Balaramamoorthy, K. (Bhabha Atomic Research Centre, Bombay). pp 236-50 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Aspects of materials development for use in nuclear technology are discussed. Information is included on nuclear fuel cladding materials, pressure tube materials, pressure vessels, uses of alloy steels, and nonferrous tubes for heat exchangers. (J.R.D.)

45061 COPPER AND ITS ALLOYS IN SPECIALIZED APPLICATIONS. Vaidyanath, L. R.; Bhandary, V. S. (Indian Copper Information Centre, Calcutta). pp 474-99 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Development and uses of copper and its alloys are reviewed. Discussions are included on electric conductors, properties of dispersion hardened copper, electronic applications, uses in electric power distribution, wave guides, uses in nuclear research, and in aerospace development. (J.R.D.)

45062 INFLUENCE OF GRAIN SIZE ON THE MECHANICAL PROPERTIES OF ALPHA ZIRCONIUM. Ramani, S. V.; Rodriguez, P. (Bhabha Atomic Research Centre, Trombay, India). pp 1-16 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Results of research are reported aimed at determining whether variations in work hardening and grain size are related to recovery from deformation by alpha-phase zirconium. The Hall-Petch parameters and their variation with temperature are evaluated. (J.R.D.)

45063 DEFORMATION BEHAVIOUR OF ZIRCONIUM-20 WT. PERCENT TITANIUM ALLOY. Dasgupta, P. (Bhabha Atomic Research Centre, Trombay, India). pp 45-51 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Experiments are described the results of which indicate that solute additions to Zr constitute a negligible contribution to the thermal component of stress. Zirconium and Zr alloys are not altered by the activation enthalpy for deformation or the activation volume. It appears that addition of substitutional solutes raises the temperature-independent component, suggesting that the long-range interactions between dislocations are more effective in Zr solid solutions than in pure Zr. (J.R.D.)

45064 POTENTIAL OF FIBER-REINFORCED COMPOSITE MATERIALS. Ramakrishnan, P. (Indian Inst. of Tech., Bombay). pp 230-46 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Properties and uses of composite materials are reviewed. Information is included on development of fiber-filaments and whiskers, performance of matrix materials, compatibility of fibers and matrices, methods of composite fabrication, Cu composites, and unidirectional solidification of Al-Ni alloys. (J.R.D.)

45065 FRACTURE TOUGHNESS MEASUREMENTS ON FORGINGS OF 22Ni-37Cr-Mo STEEL. Klausnitzer, K. Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 4, 188-9 (Apr 1971). (In German).

The determination of the fracture toughness (K_{Ic}-value) of pressure vessel steel was an important objective of the brittle fracture testing program conducted by Siemens AG. Three samples of forged 37Cr-Mo-22 Ni pressure vessel steel were tested at temperatures from 25 to 190°C in accordance with the ASTM-E399-70T standard for test performance and evaluation. The K_{Ic} values obtained were compared with K_{Ic} values obtained from testing samples of 12 in.-thick plates of ASTM A533B Class 1 steel. The range of K_{Ic} values measured was similar to that observed in the US Heavy Section Steel Technology program. (L.C.L.)

45066 THERMOPHYSICAL PROPERTIES OF HOT-PRESSED BERYLLIUM. Tye, R. P. (Dynatech R/D Co., Cambridge, Mass.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 326-34(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

Measurements of thermal conductivity, electrical resistivity, and heat capacity of hot-pressed beryllium were made on twelve samples over the approximate range 300 to 1300°K with a high accuracy. Analysis of the results indicates: the small variations in the thermal and electrical conductivities can be attributed to small differences in chemical composition; the lattice component of thermal conductivity is proportional to the inverse of the absolute temperature; at 1300°K, there is still a 20 percent lattice component of thermal conductivity; the specific-heat measurements are in excellent agreement with results published previously for beryllium metal. (France)

45067 SOME ANOMALOUS THERMAL DIFFUSIVITY RESULTS OF HAFNIUM, NIOBIUM, AND ZIRCALOY-2. Wheeler, M. J. (General Electric Co., Ltd., Wembley, Eng.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 335-40(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

The results of thermal diffusivity measurements by the modulated electron-beam technique are given for specimens of hafnium between 800 and 1700°K, niobium between 1050 and 2050°K, and Zircaloy-2 between 600 and 950°K. The thermal diffusivity of hafnium appears to be directly proportional to the thickness of the specimen, and a similar thickness effect is also found for Zircaloy-2. The results for niobium have a larger scatter that is normally found by this measurement technique. The surfaces of the hafnium and Zircaloy-2 specimens had oxide coatings before and after the measurements. Since these materials can absorb large quantities of oxygen as a solid solution, the apparent thickness effect is probably due to the different amounts of absorbed oxygen in the individual specimens. The large scatter in the results for niobium is probably due to the oxidation and de-oxidation of the specimens during the measurements. The wide disagreements in the published thermal conductivity results for the Group IV elements, Ti, Zr, and Hf, and the Group V elements V, Nb, and Ta are probably due to their oxidation mechanisms. (France)

45068 THERMAL DIFFUSIVITY OF TUNGSTEN IN THE RANGE 1000 TO 2500°K. Ferro, C.; Patimo, C.; Piconi, C. (Casaccia Nuclear Research Center, Rome). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 346-350(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

Within the AGARD program and with the aim of determining high-temperature standards, some measurements were made on the thermal diffusivity of commercial tungsten by means of the flash technique. The data obtained showed a spreading of approximately 5 to 10%, probably due to structural modifications of the sample during test. This batch of material should not be considered as a standard unless further annealing is performed and its characteristics determined. Metallographic examinations confirm this view. (France)

45069 MEASUREMENT OF MELTING POINT AND ELECTRICAL RESISTIVITY (ABOVE 2840°K) OF MOLYBDENUM BY A PULSE HEATING METHOD. Cezairliyan, A.; Morse, M. S.; Beckett, C. W. (National Bureau of Standards, Washington, D. C.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 382-8(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

A pulse heating method was used to measure the melting point and electrical resistivity of molybdenum in the temperature range 2840 to 2889°K. The specimen was heated from room temperature to its melting point in approximately 0.8 sec. Specimen temperature is measured with a high-speed photoelectric pyrometer. During the heating period, voltage, current, and temperature are recorded with a high-speed digital data acquisition system which has a fullscale signal resolution of approximately one part in 8000, and a time resolution of 0.4 msec. Results are compared with those in the literature. Estimated inaccuracy in the melting point (2889°K) and in electrical resistivity is 10°K and 0.5 per cent, respectively. (France)

45070 MEASUREMENT OF THE FRACTURE DUCTILITY (K_{Ic}) OF METALLIC MATERIALS BY MEANS OF COMBINATION SAMPLES. Klausnitzer, E. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 4, 190-2(Apr 1971). (In German).

In evaluating the brittle fracture safety of reactor pressure vessels it is important to know the fracture toughness (K_{Ic}) of the pressure vessel material. The difficulties in determining K_{Ic} values for thick-section steels, including those which have undergone radiation embrittlement, are discussed. A method is described for measuring the K_{Ic}-value for a material using composite materials-testing samples formed by soldering or welding either a small rectangular block of the original material between blocks of auxiliary material or a small solid cylindrical sample of the original material in a hole cut through a solid block of auxiliary material. The fracture toughness of solid $^{37}Cr-Mo-^{22}Ni$ steel was measured at −196°C using a 1-in.-thick Compact Tension Specimen as specified in ASTM Designation E399-70T. The fracture toughness of each of the two types of composite samples containing $^{37}Cr-Mo-^{22}Ni$ steel as the original material and St 50 as the auxiliary material was measured under the same test conditions. The K_{Ic} values obtained with the composite test pieces were identical to that obtained with the solid specimen. A comparison of the fracture surfaces showed no distinguishable differences. Further research is recommended to determine the usefulness of composite samples in the measurement of fracture toughness at higher temperatures. (L.C.L.)

Structure and Phase Studies

Refer also to abstracts 45591 and 45611.

45071 (NLCO-1065) INFLUENCE OF MINOR COMPONENTS ON THE HIGH-TEMPERATURE DEFORMATION STRUCTURE OF URANIUM. Rhines, F. N. (National Lead Co. of Ohio, Cincinnati). Jun 1971. Contract AT(30-1)-1156. 23p. Dep. NTIS.

The pattern of hot deformation flow in polycrystalline α-uranium was studied on a laboratory scale. Three-dimensional models of selected grains were reconstructed from photomicrographs of serial sectioned specimens of both hot deformed and annealed uranium. Analysis of these models, prior work, and the work of others indicate that serrated grain boundary outlines do correspond with three-dimensional indications of non-crystallographic block shearing. From this study, a new hypothesis is proposed for a mechanism of radiation swelling. (auth)

45072 (UCRL-13402) EXPERIMENTAL INVESTIGATION OF DELAYED ACOUSTIC EMISSION IN BERYLLIUM. Adams, K. H.; Bass, B. R.; Borhaug, J. E.; Goodman, C. H.; Thompson, H. A. (Tulane Univ., New Orleans, La. Dept. of Mechanical Engineering). Mar 1969. 67p. Dep. NTIS.

For California Univ., Livermore. Lawrence Radiation Lab.

Specimens of high-purity, annealed beryllium were maintained isothermal and subjected to steady tensile loads for extended time periods. During these periods the acoustic emission from the specimens was recorded. The time period of these steady conditions extended from the time of application of the load, when the emission was a maximum, to the point where the emission activity had decayed essentially into the background noise of the instrumentation. The load on each specimen was increased incrementally so that the uniform tensile stress at the test section of specimen was varied monotonically through the yield strength up to the fracture point. The investigated temperature range extended from an ambient of about 80 up to a maximum of 200°F. Analyses of these delayed acoustic emission data showed that the rate of emission in these tests did not decay linearly with the time. Instead the rate appeared to approach asymptotically an exponential dependence upon the time. Attempts to correlate these data on a semiempirical basis resulted in several indications that the emission phenomena may be related to the creation of vacancies in the crystal lattice, although additional data are necessary to pursue this possibility further. As a part of this project, techniques and procedures were developed using zinc for the purpose of safely performing post-stress, metallographic examinations of the surface of the beryllium specimens. The funds and time of the project were exhausted before these examinations could be performed. (auth)

45073 THERMODYNAMICS OF THE LANTHANIDE ELEMENTS AT MODERATE TEMPERATURES (20° TO 273°). Semenchenko, V. K.; Badra, Kh. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 44: No. 11, 1556-62 (1970).

The nature of the stability of lanthanide metals at moderate temperatures (between 20 and 273°K) was investigated to elucidate the nature and type of the phase transitions occurring in this temperature range in all the lanthanides except promethium. The phase transitions in all the elements are of the post-critical type. (auth)

45074 SYSTEMS ZIRCONIUM-CHROMIUM-ALUMINUM AND ZIRCONIUM-COPPER-ALUMINUM. Markiv, V. Ya.; Burnashova, V. V. (Inst. of Materials Science, Kiev. L'vov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 998-1002(Dec 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 53-8(Dec 1970).

Using x-ray and metallographic analyses, a study was made of alloys of the systems Zr−Cr−Al and Zr−Cu−Al. The two systems differ fundamentally in the character of the reactions taking place in them. In the system Zr−Cr−Al, the starting components react with each other without forming any ternary compounds. The isothermal section of the system Zr−Cr−Al at 800°C is characterized by the formation of a solid solution of chromium in $ZrAl_2$ (up to ~54 at. %). In the system Zr−Cu−Al at 800°C, eight ternary phases (K, U, Π, H, λ_2, Z, ψ, and N) participate in phase equilibria. In the aluminum-rich alloys, one more ternary phase (E) forms at 500°C. The structure of the ψ-phase was established. (auth)

45075 NEUTRON RADIOGRAPHY OF UNIDIRECTIONALLY SOLIDIFYING Sn-Cd ALLOYS. Reijonen, H.; Forsten, J. (Helsinki Univ., Otaniemi, Finland). Met. Trans.; 2: No. 7, 1921-4(Jul 1971).

The use of neutron radiography in revealing the solidification process in Sn−Cd alloys is described. It is shown that segregation of cadmium in the liquid and solid as well as in front of the solid-liquid interface occurs. From the respective neutron radiographs an easy evaluation of the partition and diffusion coefficient is pos-

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sible. An estimate was made of the temperature of the solid-liquid interface using the observed solute concentrations and the Sn–Cd phase diagram. (auth)

45076 EFFECT OF MOBILE INTERSTITIALS ON THE NUCLEATION OF VOIDS. Burton, J. J. (Columbia Univ., New York). Scr. Met.; 5: No. 6, 449-58(Jun 1971).

The effects of mobile interstitials on void nucleation were examined. The results of the study are expressed in a form suited to easy calculation of nucleation rates. The rates for austenitic steel are calculated as an example. (J.R.D.)

45077 COMMENTS ON THE STRENGTH-DIFFERENTIAL PHENOMENON IN ZIRCALOY-2. Snowden, K. U. (Australian Atomic Energy Commission, Sutherland). Scr. Met.; 5: No. 6, 467-8(Jun 1971).

A model for strength-differential effects in Zircaloy-2 is presented. The texture of Zircaloy-2 plates is usually one in which the basal poles are clustered around the normal to the broad surface of the plate. When stress is applied approximately parallel to the basal poles then prism slip is difficult and the formation of $\{11\bar{2}2\}$ twins is favored in compression whereas the formation of $\{10\bar{1}2\}$ and $\{11\bar{2}1\}$ twins is favored for tensile stress. Twinning occurs more easily in compression than in tension. (J.R.D.)

45078 STRESS INDUCED DIFFUSION OF OXYGEN IN ALPHA-ZIRCONIUM. Browne, K. M. (John Lysaght (Australia) Ltd., Newcastle). Scr. Met.; 5: No. 6, 519-23(Jun 1971).

Investigations conducted to determine whether an oxygen peak occurs in alpha–zirconium are described. It was found that an internal friction peak arises from the stress-induced diffusion of O in Zr. The mechanism by which it occurs was not determined. (J.R.D.)

45079 EFFECT OF THERMAL CYCLING ON THE STRESS ORIENTATION OF HYDRIDE IN ZIRCALOY. Mishima, Y.; Okubo, T.; Sano, E. (Tokyo Univ.). Met. Trans.; 2: No. 7, 1995-7(Jul 1971).

The effect of thermal cycling under internal pressure on the orientation of hydride platelets in Zircaloy-2 fuel cladding tubes was investigated. Tubes with two fabrication histories, cold rolled and cold drawn, were autoclaved in pressurized steam at 400°C for 14 days for hydriding. The orientation of the hydride platelets in the cold rolled tube was primarily circumferential; whereas, in the cold drawn tube, the orientation was both circumferential and radial. Thermal cycling without internal pressure did not cause reorientation but caused a reduction in platelet size. Thermal cycling under stress caused changes in both size and orientation even after a single cycle. Almost all the platelets became oriented radially after ten cycles in both types of tubing and little or no change occurred with additional cycling. (auth)

45080 STRUCTURAL CHANGES IN NIOBIUM, TANTALUM, AND Nb–Mo ALLOY DURING LOCAL DEFORMATION. Gorelik, S. S.; Spektor, E. N. (Moscow Inst. of Steel and Its Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 151-2(1971). (In Russian).

Structural changes in the metal resulted from deformation by stamping of samples of Nb, Ta, and Nb + 4% Mo alloy. The samples had previously been rolled with an 80% reduction and then heated in a vacuum until the onset of recrystallization. The thickness of the samples was 1.4 mm and the depth of the stamp was 0.5 mm. Stamping resulted in significant microstrain. Characteristic x-ray lines were washed-out in the localized stamped area, but the anticipated increase in microhardness was not realized. Local deformation by stamping of specimens of Fe, Mo, W, Cu, Ni, Ni–20% Cr, Cu–7% Al, Zr, and Ti did not produce structural changes similar to the above. (K.S.W.)

45081 ELECTRON MICROSCOPY STUDY OF THE PRECIPITATION PROCESSES IN Cu-2 WT. PERCENT Be ALLOY. Shimizu, Ken'ichi (Osaka Univ.); Mikami, Yasuharu; Mitani, Hiroyasu; Otsuka, Kazuhiro. Trans. Jap. Inst. Metals; 12: No. 3, 206-13(May 1971).

In order to make clear the precipitation processes in Cu–Be alloy, the structural changes upon aging of the 2 wt % Be alloy were examined in detail through an electron microscopy in particular by the use of the selected-area electron diffraction technique. The change in electron diffraction patterns with increasing aging time or temperature was as follows. In the earliest stage, long streaks appeared in the $\langle 001 \rangle$ directions due to the formation of Guinier–Preston (G.P.) zones. Upon prolonged aging, the streaks became shorter and intensity maxima appeared at about $\frac{2}{3}$ of $\{002\}$ reciprocal lattice vectors. This stage is distinct from the G.P. zone formation and may correspond to the formation of the γ'' phase. The structure of γ'' is considered to be a body-centered tetragonal, with Cu atoms at the corner and Be atoms at the body-center, and is different from that proposed by Geisler et al. Aging at higher temperatures caused another superlattice reflection [CuAu(II) type, γ'] to appear and $\frac{2}{3}$ reflections mentioned above to split. This splitting corresponded to the formation of the γ phase. From these observations, it was concluded that the aging sequence is $\alpha \rightarrow$ G.P. zone $\rightarrow \gamma'' \rightarrow \gamma' \rightarrow \gamma$. The structure of the final precipitate γ was identified to be the same as that of the equilibrium phase with the lattice constant 2.71 A. Then a new orientation relationship between the γ and α was proposed, such that $\{103\}_\gamma // \{113\}_\alpha$, $\langle 010 \rangle_\gamma // \langle 1\bar{1}0 \rangle_\alpha$. Among several orientation relationships reported so far, only this one was consistent with our experimental results. In spite of the identity in structure, the final precipitates γ were associated with strain contrast around themselves, in contrast to the equilibrium phase. This fact suggests that the transformation γ' to γ might be martensitic in the nucleation stage. The mechanism of γ' to γ transformation is discussed along this line and from the viewpoint of coherency. (auth)

45082 ELECTRON MICROSCOPIC OBSERVATION ON THE PRECIPITATION SEQUENCE IN Cu–Be ALLOYS. Yamamoto, Satoru; Matsui, Masaaki; Murakami, Yotaro (Kyoto Univ.). Trans. Jap. Inst. Metals; 12: No. 3, 159-65(May 1971).

Electron microscopic observation on the precipitation sequence in Cu–Be alloys was carried out. Clear images of Guinier–Preston zones on $\{100\}$ planes, the ordered phase, the intermediate γ'-phase, the equilibrium γ-phase, and then the information about the size, shape, and distribution in each stage were obtained more clearly than before. Strains associated with precipitates in the early stages of aging and some lattice defects such as dislocations, twins and stacking faults were observed, and these mean that the precipitation in Cu–Be alloys is associated with an exclusively large strain. These electron microscopic results were discussed as compared to those obtained by other methods. (auth)

45083 X-RAY STUDIES IN THE SYSTEM $ZrNi_{5-x}Al_x$. Blazina, Z.; Ban, Z (Univ., Zagreb). Croat. Chem. Acta.; 43: No. 1, 59-63(1971).

X-ray and micrographic investigations in the system $ZrNi_{5-x}Al_x$ revealed the existence of a continuous series of solid solutions $ZrNi_5$–$ZrNi_4Al$. The lattice parameter increases monotonously from 6.710 to 6.748 Å. Beyond the composition $ZrNi_4Al$ the samples are of a two phase nature. The x-ray intensity calculations confirmed the postulated substitution of nickel atoms in the position 4(c) in the space group F43m (No. 216). A possible influence of oxygen upon the formation of these compounds is briefly discussed. (auth)

45084 TWINNING IN ALPHA-NEPTUNIUM. Rechtien, J. J. (Argonne National Lab., Ill.); Crocker, A. G.; Nelson, R. D. J. Nucl. Mater.; 40: No. 2, 134-40(Aug 1971).

Twinning in α-neptunium has been analyzed experimentally and theoretically. The geometric theory based on minimum shear and shuffles is shown to predict twinning elements $K_1K_2\eta_1\eta_2$; g as $\{110\}\{1\bar{1}0\}\langle 1\bar{1}0 \rangle\langle 110 \rangle$; 0.068. Habit plane analysis on single crystals and relative twin orientations in polycrystalline material, studied by color metallography, confirm this prediction. (auth)

45085 RECRYSTALLIZATION OF TWO-PHASE ALLOYS. Bhatia, M. L. (National Aeronautical Lab., Bangalore, India). pp 64-77 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Conditions are outlined under which acceleration and retardation of recrystallization are likely. Information is included on drag at grain boundaries due to second phase particles, retardation of nucleation and growth of grains, and recrystallization of two-phase alloys as affected by porosity. (J.R.D.)

45086 TRANSMISSION ELECTRON MICROSCOPIC STUDIES OF COLD-ROLLED ZIRCONIUM. Mukhopadhyay, P.; Banerjee, S.; Krishnan, R. (Bhabha Atomic Research Centre, Trombay, India). pp 352-64 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

The slip planes in deformed zirconium are found to be the prismatic and the pyramidal planes, in contrast with the cases of other hcp metals such as zinc, cadmium, and magnesium where basal slip is predominant. In sponge zirconium, slip is found to be almost totally confined to planes of the type $(10\bar{1}0)$, while in crystal bar zirconium, where the dislocations are expected to be more mobile, slip appears to occur as well on pyramidal planes and prismatic planes. The room temperature deformation of zirconium appears to occur by slip and twinning; the former is responsible

for the larger fraction of the total deformation. The rate of straining appeared to be an important factor in the formation of twins. In view of the results of the electron beam heating experiments, it seems likely that climb of edge dislocations could be operative at comparatively higher temperatures, the movement of point defects essential for the process to occur being favored and expedited by irradiation of the foil within the electron microscope. (auth)

45087 X-RAY STUDY OF COLD WORKED BCC TANTALUM–NIOBIUM AND TANTALUM–MOLYBDENUM ALLOYS. Kumar, Lalit; Krishnan, R. (Bhabha Atomic Research Centre, Trombay, India). pp 453-70 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

The stacking fault probabilities of Ta-Nb alloys and Ta-Mo alloys were investigated. It was found that in these alloys the particle sizes in the same direction were limited to a fairly narrow range, and were different in different directions, showing the anisotropy of the particle size distribution. The ratio $D_c(110)/D_c(200)$ as well as the compound fault probability $(1.5\ \alpha + \beta)$ appeared to have a maximum value corresponding to the compositions Ta–40 at. % Nb and Ta–40 at. % Mo of the alloys. (auth)

45088 CHARACTER OF THE U_3Si TWINNING. Zberea, Irina (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 3, 361-5(1971).

The crystallographic elements of U_3Si twinning are calculated, knowing that the twins which appear in U_3Si compound are of (102) type. The data are most conveniently verified on the (010) reciprocal lattice section, the (010) plane being the shear plane. (auth)

Radiation Effects

Refer also to abstracts 44487, 45151, and 46059.

45089 (AEC-tr-7236) IMPORTANT ROLE OF FISSION PRODUCTS OF LARGE ATOMIC RADIUS: CESIUM, STRONTIUM, BARIUM, CERIUM, AND NEODYMIUM IN SWELLING OF URANIUM. Blanchard, P. Translated from J. Nucl. Mater.; 26: 241-5(1968). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 34089. (auth)

45090 (ANL-7786) DESIGN, RESEARCH, AND DEVELOPMENT IMPLICATIONS OF METAL SWELLING IN FAST REACTORS. Huebotter, P. R.; Bump, T. R.; Sha, W. T.; Eggen, D. T.; Fulford, P. J. (Argonne National Lab., Ill.). Apr 1971. Contract W-31-109-eng-38. 124p. Dep. NTIS.

This report defines the problems created by core-metal swelling by analyzing the impact of this recently discovered phenomenon on the design of the total reactor system and individual reactor components. This analysis is performed in the context of the state of the art in fast-reactor core design and the properties of fast reactors that cause concern over dimensional instability of structural materials. Following this problem-definition presentation, the advantages, disadvantages, and research and development implications of the various potential solutions are discussed, and a preliminary screening is offered as a guide to further work. The methods are grouped as follows: mechanical–physically accommodating the metal swelling; neutronic–decreasing high-energy fluence on core and core-proximity hardware; metallurgical–strategically substituting nonswelling or low-swelling refractory materials for commercial stainless steel; operational–reducing the amount of swelling and/or the consequential problems by modifying operating conditions and/or operating practices. Because of the diversity of potential solutions, fast-reactor research and development in the future will be influenced greatly by the combination of solutions that evolves into a commercial strategy for coping with the problem of metal swelling. The principal research and development recommendations are as follows: The highest priority activity within the scope of short-range research related to metal swelling and its accommodation should be to resolve the uncertainty of whether significant radiation-enhanced creep occurs at high fluences. Development of a low-swelling or nonswelling variety of stainless steel should be regarded as having the highest priority among long-range core-related research and development projects, with perhaps one-tenth as much effort devoted to an economically viable backup structural material (e.g., molybdenum). (auth)

45091 TRANSIENT BEHAVIOR OF HIGH-SWELLING EBR-II MARK-IA DRIVER FUEL IN TREAT. Rothman, A. B.; Renken, C. J.; Stewart, R. R.; (and others) (Argonne National Lab., Ill.). Nucl. Eng. Des.; 15: No. 2, 187-207(1971).

Results of transient studies on high-swelling Mark IA driver fuel indicated that temperatures at clad failure, even with irradiated elements, were not significantly lower than clad failure temperatures for normal low-swelling fuel. These temperatures represent thresholds far in excess of the temperature conceivable for postulated overpower or loss of coolant conditions in EBR-II. In addition to high-speed color photography and cladding temperature measurements, the test capsule was outfitted with electromagnetic motion transducers to follow pre-failure fuel movements. This instrumentation proved to be a powerful tool, both in the determination of the prompt negative feedback reactivity available from fuel expansion, and the description of clad failure phenomena. The nature of cladding failure was similar to observations on normal fuel. Two possible mechanisms for the release of stress from the restricted expansion of sodium trapped between the fuel and cladding, appear to be either motion of fuel axially to break the weak interaction forces between the fuel and cladding, or compression of the highly swollen fuel. (auth)

45092 IRRADIATION-PRODUCED DEFECTS IN AUSTENITIC STAINLESS STEEL. Brager, H. R.; Straalsund, J. L.; Holmes, J. J.; Bates, J. F. (WADCO Corp., Richland, Wash.). Contract AT(45-1)-2170. Met. Trans.; 2: No. 7, 1893-1904(Jul 1971).

The microstructure of annealed AISI Type 304 and Type 316 stainless steels was characterized by transmission electron microscopy as a function of fast reactor irradiation at fluence levels from 4×10^{21} to 7×10^{22} n per sq cm (E > 0.1 MeV) and at irradiation temperatures from 370 to 700°C. Several irradiation produced defect types were found: voids, Frank faulted loops, perfect loops, dislocation networks, and precipitates. Void number density obeys a power law relationship to fluence, wherein the exponent increases with increasing temperature from 0.8 to 1.4 over the irradiation temperatures investigated. The void size is nearly independent of fluence and increases with increasing temperature. The upper limit irradiation temperature for void formation is about 650 to 700°C. The density and size of Frank faulted loops followed trends similar to those found for voids to temperatures of ~550°C where unfaulted loops, perfect loops, and dislocation networks coexist. These experimental results do not confirm predictions of recently advanced models of void formation. The major deficiency of these models appears to be the nucleation rate. Accordingly, empirical nucleation rates were used to formulate a diffusion-controlled void growth model. This model was found to closely describe experimentally determined void growth kinetics. (auth)

45093 NEUTRON IRRADIATION DAMAGE IN MOLYBDENUM. PART III. POINT DEFECT CLUSTERS IN A LOW DOSE IRRADIATION AT 77°K. Maher, D. M.; Loretto, M. H.; Bartlett, A. F. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 24: No. 187, 181-94(Jul 1971).

Electron transmission microscopy was used to study defect clusters in neutron-irradiated molybdenum. Bulk specimens having resistivity ratios, $\rho_{293°K}/\rho_{4.2°K}$, ~175 and ~7500 were irradiated to a dose of 4.65×10^{17} fission n. cm^{-2} at 77°K. Diffraction contrast experiments at ~300°K showed that visible strain centers are present in both materials following the irradiation. Estimates of the apparent volume density, N_c, of clusters indicate that $N_c > 5 \times 10^{16}$ cm^{-3} in the lower resistivity ratio material and $N_c \sim 6 \times 10^{15}$ cm^{-3} in the higher resistivity ratio material. Detailed studies on the latter material indicated that the observed image topographies are consistent with those expected from aggregates of point defects in the form of dislocation loops having Burgers vector directions of the types ⟨110⟩ and ⟨111⟩. Moreover, stereoscopic measurements of the depth dependence of these images, interpreting the resulting layer structure in terms of theoretical intensities appropriate when the black–white intensity distribution is determined by the edge component of a small dislocation loop, suggest that ~80% of the observed clusters are interstitial in nature. A comparison between the defect structures of the two materials investigated was interpreted as indicating that impurities play an important role in determining the scale of nucleation and hence the extent of growth of the dominant interstitial aggregate. Finally, as a consequence of these observations it was concluded that long-range migration of an interstitial point defect occurred at mean temperatures substantially below the stage III recovery peak (i.e. T = 423 to 473°K) of induced electrical resistivity in neutron-irradiated molybdenum. (auth) (UK)

45094 FRUIT DEVICE FOR THE CONTINUOUS STUDY OF CREEP. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 109-10(Nov-Dec 1970). (In French).

This device was designed for studying the in-pile creep of uranium samples under stresses with the Triton reactor. Two locations are available for positioning the device. The measurements obtained from the Fruit device depend upon the stability of the information received from the transducer. (France)

45095 EFFECT OF THE INTERSTITIAL CLUSTER ON THE LATTICE EXPANSION OF IRRADIATED METALS. Hanada,

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Reimon (Tohoku Univ., Sendai). Trans. Jap. Inst. Metals; 12: No. 3, 192-6(May 1971).

Lattice parameter and length change were formulated as a function of irradiation dose on the hypothesis that an interstitial ceases to cause the lattice parameter change after interstitial clusters grow up to a certain size, whereas the interstitial still contributes to macroscopic volume change by one atomic volume. The resultant formula was applied to the experimental results obtained by Kissinger et al. and Gray and Cummings on the lattice parameter and volume change in neutron irradiated Mo. The hypothesis is found to be capable of explaining several features of the experimental results in a consistent manner. The nature of stage III defects in Mo was also discussed in conjunction with the experimental results. (auth)

45096 EFFECT OF TENSILE TEST CONDITIONS ON THE FRACTURE BEHAVIOUR OF 20Cr–25Ni–Nb STABILISED STAINLESS STEEL AFTER HIGH-TEMPERATURE IRRADIATION. Sumerling, R.; Rhodes, D. (United Kingdom Atomic Energy Authority, Windscale, Eng.). J. Nucl. Mater.; 40: No. 2, 121-33(Aug 1971).

Tensile specimens were cut from 20Cr–25Ni–Nb stabilized austenitic steel tubes irradiated at 650 to 700°C, in contact with UO_2 fuel at their inner surfaces and CO_2 at their outer surfaces, to a thermal neutron dose between 1 and 10×10^{20} nvt. Tensile tests were made at temperatures between 450 and 800°C using three strain-rates in the range 1.4×10^{-3} to 1.4×10^{-6}/sec. The results were correlated using the expression $\sigma_t^n = K\dot{\epsilon} \exp(Q/RT)$, where σ_t is the flow stress and n is an index which proves to be close to 7. Under test conditions giving full recovery-creep an activation energy Q of ~68.5 kcal/mole was obtained for the irradiated specimens and ~80 kcal/mole for unirradiated thermal control specimens. The tensile elongation and rupture mode of the specimens were also related to the Zener–Holloman parameter $Z = \log_{10}[\dot{\epsilon} \exp(Q/RT)]$. The intergranular fracture mode of the irradiated specimens varied from development of microcracks at the higher values of Z to cavitation at lower values. The reduced ductility observed on the irradiated tubing is discussed in terms of the effect of helium from the $^{10}B(n,\alpha)^7Li$ reaction on intergranular crack and cavity development. The fission-fragment-bombarded zone at the tube bore was ~10 μ thick and contained numerous gas bubbles of 20 to 100 Å dia. This zone apparently had little overall effect on the ductility of the tubing. (auth)

45097 INFLUENCE OF ZIRCONIUM ADDITIONS ON THE MECHANICAL PROPERTIES OF A Ni–Mo–Cr ALLOY IN THE IRRADIATED AND UNIRRADIATED CONDITIONS. McCoy, H. E.; Gehlbach, R. E. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 40: No. 2, 151-65(Aug 1971).

The effects of zirconium additions on the mechanical properties of alloys having the base composition Ni-12 wt % Mo-7 wt % Cr-0.2 wt % Mn-0.05 wt % C were studied. Zirconium levels studied ranged from 0 to 1.18 wt % and included small laboratory melts and three 45-kg commercial melts. Generally, zirconium improved the strength and the fracture strain in both the irradiated and unirradiated conditions. The most dramatic effects were noted in the postirradiation creep tests, where as little as 0.05 wt % zirconium improved the rupture life and the fracture strain. This improvement is attributed to the formation of very fine MC-type carbides in the alloys containing zirconium. Zirconium addition of only 0.05 wt % led to weld metal cracking. (auth)

45098 PRODUCTION OF VOIDS IN NICKEL WITH HIGH ENERGY SELENIUM IONS. Kulcinski, G. L.; Brimhall, J. L.; Kissinger, H. E. (Battelle-Northwest, Richland, Wash.). J. Nucl. Mater.; 40: No. 2, 166-74(Aug 1971).

Irradiation of high purity (99.9 wt %) nickel at 525°C with 6 to 11 MeV selenium ions produced voids in the metal. In general, the size and number density of the voids increased with displacement damage up to approximately 50 displacements per atom (dpa). Irradiation to higher displacement densities caused a slight reduction in the average size and a continued increase in the number density of voids. The resultant swelling was found to increase as the 1.45 power of the displaced atom density until approximately 50 dpa. The volume change appears to saturate at approximately 4 to 5% in the 100 to 400 dpa range. A face centered cubic superlattice of voids was discovered in nickel which had been irradiated to 400 dpa. (auth)

45099 VOID COARSENING IN HIGH PURITY ALUMINUM DURING POSTIRRADIATION ANNEALING. Houston, J. T.; Farrell, K. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 40: No. 2, 225-9(Aug 1971).

The annealing response of voids in Al as related to neutron flux parameters is examined. Models of variability in annealing response are offered and the mechanism of void coarsening is explained. (J.R.D.)

45100 PREPARATION TECHNIQUE FOR EVALUATION OF LARGE VOIDS IN IRRADIATED STAINLESS STEEL. Wolff, Ursula E. (General Electric Co., Pleasanton, Calif.). Contract AT(04-3)-189. J. Nucl. Mater.; 40: No. 2, 230-2(Aug 1971).

A method is described of preparing stainless steel specimens having undistorted intersections between voids and plane surfaces by bombarding rotating specimen surfaces with Ar ions. Use of the technique yields nearly plane surfaces with undistorted void intersections. These surfaces can be replicated and are suitable for quantitative measurements of void sizes too large for evaluation by thin foil transmission electron microscopy. In the specimens evaluated, void diameters >2000 Å previously found in thin foils were confirmed by the new technique. (J.R.D.)

45101 COMPARISON OF RADIATION DAMAGE IN MOLYBDENUM AND SOME MOLYBDENUM-BASE ALLOYS. Rau, R. C.; Moteff, J.; Ladd, R. L. (Univ. of Cincinnati). Contracts AT(40)-2847 and AT(11-1)-2093. J. Nucl. Mater.; 40: No. 2, 233-5(Aug 1971).

Results of examination of irradiated binary molybdenum-based alloys of high and low alloy content are described. The results are compared with observations of similarly irradiated pure molybdenum. Specimens used for the study included commercial purity molybdenum, Mo-1 at. % Ti, and Mo-34 at. % Re, in the form of 0.5 mm thick sheet, irradiated to various fast (E > 1 MeV) neutron fluences at reactor ambient temperature, about 70°C. Unalloyed molybdenum was irradiated to 4×10^{19} and 1×10^{20} n/cm^2, the Mo-1 at. % Ti alloy was irradiated to 3×10^{19} and 3×10^{20} n/cm^2, and the Mo-34 at. % Re alloy was irradiated to 4×10^{19} n/cm^2. Examination of unalloyed molybdenum showed the expected high density of small black-spot defect clusters in the specimen irradiated to the lower fluence, (4×10^{19} n/cm^2) but revealed a lower density mixed population of black-spot defects, larger aggregates, and dislocation segments in the specimen irradiated to the higher fluence (1×10^{20} n/cm^2). The explanation of this anomaly is believed to lie in the effect of overlapping strain fields as the cluster density increases with increasing neutron fluence. With increasing irradiation, it is thought that the cluster density becomes so great that the strain fields of adjacent defects overlap and interact, causing the small clusters to collapse and coalesce into a smaller population of large dislocation loops and tangled networks. (J.R.D.)

45102 IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Sivaramakrishnan, K. S.; Sharma, B. D.; Rodriguez, P. (Bhabha Atomic Research Centre, Trombay, India). pp 310-24 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218–(Vol.1).

A review of information on radiation hardening of reactor materials emphasizing steels and Zr-base alloys is presented. Information is included on dose-damage characteristics in radiation hardening, radiation effects on impact properties, radiation damage recovery, and mechanisms of radiation hardening. (J.R.D.)

Ceramics and Cermets

Refer also to abstracts 44988 and 44989.

45103 (CONF-710601–3) THEORETICAL CONSIDERATIONS OF MIGRATION AND COALESCENCE OF PORES IN SOLIDS BY SURFACE DIFFUSION. Gruber, E. E. (Argonne National Lab., Ill.). [1971]. 11p. Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

Results of investigations are presented to show that when swelling by random surface diffusion migration becomes significant, at swelling above about 0.6%, the mean radius and swelling should increase as $t^{\frac{1}{4}}$ rather than $t^{\frac{1}{2}}$ as predicted in an approximate treatment. Although the critical swelling, 0.6%, is subject to a more detailed investigation of the swelling behavior (where both terms are considered simultaneously), the fact that it exists and is relatively small is itself of value in further studies. Results of preliminary calculations based on such equations indicate that the mean radius and swelling due to random migration by surface diffusion on grain boundaries and on dislocations vary respectively as $t^{\frac{1}{6}}$ and as $t^{\frac{1}{3}}$. (auth)

Corrosion and Erosion

Refer also to abstract 46229.

45104 THERMOGRAVIMETRIC STUDY OF THE OXIDATION OF ZrB_2 IN THE TEMPERATURE RANGE OF 800° TO 1500°C. Tripp, W. C. (Systems Research Labs., Dayton,

Ohio); Graham, H. C. J. Electrochem. Soc.; 118: No. 7, 1195-9(Jul 1971).

A thermogravimetric system is described for the determination of the total oxygen consumption, sample weight-change, and vaporization rate during the oxidation of $ZrBr_2$. The results show an increasing deviation from parabolic kinetics with increasing temperature at 250 mm oxygen pressure. The following equation is used to describe the total oxygen consumption in the temperature range of 800 to 1500°C, $\Delta no_2/A$ (moles O_2/cm^2) = 5.41×10^{-4} exp (–25,000/2RT) $t^{\frac{1}{2}}$ + 2.86 exp (–47,000/RT) t. Because ZrB_2 is oxidized stoichiometrically, this result can be converted to the recession of ZrB_2 as follows δ(cm) = 4.06×10^{-3} exp (–25,000/2RT) $t^{\frac{1}{2}}$ + 2.10×10^{1} exp (–47,000/RT) t. (auth)

45105 REACTION BETWEEN URANIUM CARBIDES AND LIQUID SODIUM. Watanabe, H.; Kurasawa, T.; Kikuchi, T.; Furukawa, K.; Nihei, I. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 40: No. 2, 213-20(Aug 1971).

A reaction on the surface of hyperstoichiometric UC exposed to purified sodium (estimated < 1 ppM O) for 500 to 2000 hr at the temperature of 700°C has been metallographically studied using the apparatus designed for studying compatibility. The rate of decarburization was 2×10^{-4} mm/hr for arc cast carbides and 1×10^{-4} mm/hr for sintered carbides. It becomes evident that the decarburization in the hyperstoichiometric UC is controlled by dissolution of carbon in the UC_2 phase which comes in contact with sodium penetrating through the crevices produced during the depletion of the UC_2 phase. In contrast to the arc cast carbide which was decarburized 410 μ in thickness after the exposure time of 2000 hr, the carbide of the identical carbon content which mainly consisted of the U_2C_3 phase transformed by heat treatment was decarburized only 3 μ in thickness under the same exposure condition. (auth)

45106 INTERACTION BETWEEN URANIUM CARBIDES AND LIQUID SODIUM WITH A SMALL OXYGEN CONTENT. Watanabe, H.; Kurasawa, T.; Kikuchi, T.; Katsuta, H.; Furukawa, K. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 40: No. 2, 236-8(Aug 1971).

The oxidation and the resultant carbon transfer of uranium carbides in sodium were studied by metallography and x-ray diffraction, after exposure to sodium in which dissolved oxygen was controlled by a diffusion cold trap, holding the temperature between 120 and 140°C in a static corrosion apparatus. Oxygen content in sodium was estimated to be 5 to 10 ppM during the experiment. The sodium charged was about 1.3 kg in weight. (auth)

45107 KINETICS OF THE HIGH-TEMPERATURE OXIDATION OF DISPERSION-STRENGTHENED NICKEL–NIOBIA ALLOYS. Rao, T. H.; Vasu, K. I. (Indian Inst. of Science Bangalore). pp 134-49 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Results are presented of investigations concerning oxidation of Ni–Nb_2O_5 alloys by O_2 at 700 to 950°C. In the composition range investigated (1 to 5 vol % Nb_2O_5), NiO and Nb_2O_5 form a solid solution. Results show that in the temperature range 700 to 950°C, sintered nickel undergoes two-stage oxidation (logarithmic followed by parabolic) while there are three stages of oxidation (an initial logarithmic, an intermediate linear, and a final parabolic region) in the case of nickel-niobia alloys. Nickel-niobia alloys are inferior to pure nickel in their oxidation resistance, and the effect of Nb_2O_5 in nickel is nearly the same as that due to Nb in nickel. The logarithmic and linear stages of oxidation of nickel-niobia alloys represent a phase-boundary reaction or process, such as chemisorption. The parabolic kinetics represents a diffusion process, identified as the outward diffusion of Ni^{2+} ion across the oxide scale. The oxide scales are green, glassy, transparent and non-adherent, so much so, no protection is offered by the oxide scales. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 44544, 45015, 45016, 45022, 46265, and 46344.

45108 (AECL-3673) PRESSURE SINTERING OF SILICON CARBIDE. Balloffet, Y.; Phillips, E.; Hughes, F. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Aug 1970. 39p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Small silicon carbide specimens of near-theoretical density were pressure sintered from commercial α silicon carbide powders of 3 to 6 μm grain size. Pressure sintering was carried out at 2000°C and 420 kg/cm^2 with additions of 1 wt% of aluminum. The resultant grain structure was very fine (4 to 5 μm); practically no grain growth occurred. The free silicon content of the pressure sintered specimens was no higher than in the powder itself, showing that no decomposition had occurred. Slab specimens 1 in. by $\frac{1}{4}$ in. by $\frac{1}{4}$ in. were consistently produced. In bend tests, strengths of up to 46.4 kg/mm^2 at room temperature were found for specimens with 95 to 100% theoretical density. The resultant microstructures and densities are discussed in terms of the fabrication parameters. (auth)

45109 SAFETY CONCEPTS OF THE NEW UO_2 FABRICATION PLANT OF THE RBG. Pilgenroether, A. (Nuklear-Chemie und -Metallurgie GmbH, Hanau, Ger.); Thomas, W. Atomwirt., Atomtech.; 16: 74-7(Feb 1971). (In German).

Economy of a UO_2 fabrication plant is determined by the quality of the nuclear safety concept. In earlier installations, production of safe amounts of uranium was achieved through organizational procedures and through controlled moderation. In the new installation of the RBG (reactor fuel society), unreliability of the human element is largely replaced by automatic control of safe geometry. The safety concept also encompasses radiation protection of employees and environment as well as balance of fissionable material. The installation contains numerous detection devices that allow a holdup and, thereby, an instantaneous determination of total amount of fissionable material. (tr-auth)

45110 DEVELOPMENT OF HIGH TEMPERATURE CERAMIC MATERIALS. Kulkarni, A. K.; Moorthy, V. K. (Bhabha Atomic Research Centre, Bombay). pp 208-18 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

Development of improved high-temperature commercial refractories is discussed. The importance of raw material choice is emphasized. Information is included on methods shaping and firing to develop high-temperature properties. Discussions of refractories having glassy bonding, fire-clay refractories, magnesiosilicate refractories, and pure oxide refractories are included. (J.R.D.)

45111 FABRICATION STUDIES ON UO_2. Reeve, K. D.; Ramm, E. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp AB11.1-4 of Fourth Australian Ceramic Conference Proceedings, Clayton, Victoria, Australia, 18th–20th August, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970).

From fourth ceramic conference; Clayton, Victoria, Australia (18 Aug 1970). See CONF-700841.

Pilot-scale fabrication studies on UO_2 pellets are described as one branch of a coordinated program which also incorporates powder production and basic powder studies. The plant was not designed for continuous operation, but can be operated this way with little attention, the press having a maximum output of 200 kg per 24 hrs. Sintering of the $UO_{2.05}$ to $UO_{2.15}$ powder varies between 1500 and 1700°C requiring molybdenum resistance furnaces. Other aspects considered are micronizing, precompaction-granulation, centerless grinding, washing, and drying, and lubrication. (Australia)

45112 INITIAL STAGE SINTERING OF URANIUM DIOXIDE. Woolfrey, J. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp AB14.1-2 of Fourth Australian Ceramic Conference Proceedings, Clayton, Victoria, Australia, 18th–20th August, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970).

From fourth ceramic conference; Clayton, Victoria, Australia (18 Aug 1970). See CONF-700841.

The kinetics of the initial stage of sintering of UO_2 powder in H_2 were investigated by dilatometry. Following stabilization to $UO_{2.17}$ the compacts were pressed in the range 2500 to 45,000 psi. For reduction of the green pellets, initial contraction up to 250°C was associated with the removal of physically bound water. Above 280°C the specimens began to expand with an associated increase in water release due to reduction of the excess oxygen. Complete reduction required at least 5 hr at 500°C. Green densities >45% produced violent fluctuations in shrinkage rate by affecting removal of water from the pellet structure. An apparent activation energy of 13 kcal/mole at 100 to 250°C was found for water removal. The value for the reduction step over the range 300 to 450°C was 35 kcal/mole. An apparent activation energy of 80 kcal/mole was observed for the sintering of UO_2 in the range 750 to 1200°C. No effect of green density on the apparent activation energy for the sintering process was observed. (Australia)

Properties Evaluations

Refer also to abstracts 44563, 44991, 45012, 45038, 45064, 45603, and 45605–45608.

XUM

45113 (EUR–4325) BEHAVIOR OF NUCLEAR REACTOR FUEL AT HIGH TEMPERATURE. Lindner, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 14p. (In German). Dep. NTIS (U. S. Sales Only).

Investigations of actinide diffusion have been continued for base materials such as hyperstoichiometric uranium carbide (UC_{1+1}) and platinum. The results show that the activation energy of diffusion in UC increases strongly with increasing carbon content. X-ray investigations of metallic Th-Pa alloys obtained by the Van Arkel process with Pa-contents ranging from 1 to 30% were conducted. Complete solid solution behavior was observed at Pa-contents <10%. Pure protactinium monocarbide, PaC, was prepared for the first time and its lattice structure determined. It is of the NaCl-type with $a_0 = 5.0608 \pm 0.0002$ Å. Investigations of pseudo-binary phase diagram of UC/UO by high temperature x-ray diffractometry were continued. A new study was started concerning the development of a pyrochemical reprocessing procedure for irradiated thorium fuel using the salt transport process. (auth)

45114 (LA-DC–12331) ENTHALPY OF FORMATION OF NEPTUNIUM MONOCARBIDE. Huber, Elmer J. Jr.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). [1970]. 7p. (CONF-710613–1). Dep. NTIS.

From International symposium of thermochemistry; Marseille, France (30 Jun 1971).

Measurements of ^{237}Np combustion energy were made using an oxygen bomb calorimeter. Results of the measurements are presented and are used in derivation of enthalpy of formation values. (J.R.D.)

45115 (ORNL-tr–2511) THERMAL EXPANSION OF NON-STOICHIOMETRIC ZIRCONIUM CARBIDES. Bukatov, V. G.; Rymashevskii, G. A.; Fedorov, V. B. Translated by Francois Kertesz (Oak Ridge National Lab., Tenn.), from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 3, 519-20(1971). 4p. Dep. NTIS.

The thermal expansion of nonstoichiometric ZrC at 500 to 1000°C was investigated by dilatometry. It was found that the change of linear coefficient of expansion in the homogeneous range of ZrC emphasizes the variations in bond strength, and the need to use expansion values at identical reference states along with correct identification of the material being investigated. (J.R.D.)

45116 (UCRL–51066) SEMIANNUAL PROGRESS REPORT OF THE LIGHT-ARMOR MATERIALS PROGRAM. Landingham, R. L.; Casey, A. W. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Jun 1971. Contract W-7405-eng-48. 38p. Dep. NTIS.

The evaluation of beryllium boride compounds for light-weight armor is reported. The effect of fabrication techniques on the ballistic performance is related to the microstructure of the beryllium borides and their fracture behavior under ballistic impact. The influence of impurities on the ballistic performance of these compounds is also related to the microstructure. Additional investigations on the low temperature (<1300°C) fabrication techniques (hot pressing, reaction hot pressing, and casting) and properties (other than ballistic performance) of the beryllium borides that will influence the use of these compounds for light armor are described. These investigations include 1) the toxicity of the asreceived powders and ballistic impact debris, 2) the amount and size distribution of the debris generated by the ballistic impacts, 3) the elevated-temperature oxidation, and 4) the chemical stability in fresh water and salt water of Be_4B and Be_2B. A working phase diagram of the Be-rich side (≤66.6 at. % B) is provided. (auth)

45117 PIEZO-ELECTRIC CERAMICS CONTAINING IRON AND ANTIMONY OR NIOBIUM. (to Nippon Electric Co., Ltd.). French Patent 2,002,103. 3 Oct 1969. Priority date 17 Feb 1968, Japan. (In French).

Piezo-electric ceramics are described in which the ceramic consists of a solid solution of $Pb(Fe_{\frac{1}{2}}Z_{\frac{1}{2}})O_3$, $PbTiO_3$, and $PbZrO_3$, where Z represents either Nb or Sb. MnO is present in a quantity between 0.10 and 3.0 wt.%. Up to 25 at.% of the Pb can be replaced by Ba, Sr, or Ca. The piezo-electric ceramic has a base formula represented by $[Pb(Fe_{\frac{1}{2}}Z_{\frac{1}{2}})O_3]_x[PbTiO_3]_y[PbZrO_3]_z$, where $x + y + z = 1$. (J.S.R.)

45118 HOT PRESSING OF BERYLLIUM OXIDE AND STRENGTH OF THE PRESSED SPECIMENS. Budnikov, P. P.; Kushakovskii, V. I.; Zhidkov, B. A. J. Appl. Chem. USSR (Engl. Transl.); 43: No. 9, 2107-9(Sep 1970).

Translated from Zh. Prikl. Khim.; 43: No. 9, 2090-3(Sep 1970).

The hot pressing was performed in graphite molds at 2000°C under vacuum. The compressive strength of specimens composed of crystals 5 to 10 μ in size reached 34,000 kg/cm². The relations of hot-pressing temperature with specimen strength could not be correlated. (J.R.D.)

45119 CONDENSATION COEFFICIENTS OF REFRACTORY MATERIALS. I. AlN AND BN. Hoch, M.; Ramakrishnan, D. (Univ. of Cincinnati). J. Electrochem. Soc.; 118: No. 7, 1204-11(Jul 1971).

A method was developed for determining the condensation coefficient β of component B in reactions of the type AnBM → nA(g or s) + m/2 B_2(g). Beta is measured by studying the rate of exchange of isotopically marked B_2^*(g) on the surface of AnBm. For the method to be applicable, component B must be present as a dimer (or higher) in the gas. The condensation coefficients of AlN and BN were measured using this method, employing ^{15}N nitrogen isotope. The condensation coefficients thus measured, $\beta = 5 \times 10^{-3}$ for AlN, and $\beta = 1 \times 10^{-2}$ for BN, compare favorably with values obtained by conventional methods where the kinetic pressure is compared with the equilibrium pressure. (auth)

45120 INVESTIGATIONS OF EUROPIUM OXIDE CERMETS FOR CONTROL ELEMENTS IN NUCLEAR REACTORS. Hoffmann, A.; Pant, P. (Fried-Krupp GmbH, Essen). Tech. Mitt. Krupp, Forschungsber.; 29: No. 1, 15-25(May 1971). (In German).

Europium molybdate and europium titanate as well as sintered parts from metallic powders and powders containing europium oxide were produced. These sintered parts were corrosion tested in water at 250°C. Cermet plates containing 40.75 to 51% Eu_2O_3 in the core were produced. Metallographic and radiographic examinations of the cermet plates were carried out. (auth)

45121 STRUCTURAL CONSEQUENCES OF BLACKENING IN YTTRIA-STABILIZED ZIRCONIA. Casselton, R. E. W. (International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.); Penny, J.; Reynolds, M. J. Trans. J. Brit. Ceram. Soc.; 70: No. 3, 115-20(May 1971).

Stabilized zirconia is known to be structurally weakened on blackening, with detachment of the cathode electrode. Observations on a number of polycrystalline 12 mole % Y_2O_3–ZrO_2 samples sandwiched between Pt/13% Rh electrodes and blackened under various current densities indicated that a distinction must be made between cathodic phenomena and deposition of zirconium metal in the grain boundaries of the bulk ceramic. The results are presented with special reference to samples weakly and severely electrolyzed at 10^{-1} A/cm² and 20 A/cm² respectively in argon. The resulting physical and chemical changes were examined by combined electron microprobe and x-ray analyses. (auth) (UK)

45122 COMPOSITION AND PROPERTIES OF THE BINDER IN TUNGSTEN CARBIDE–COBALT ALLOYS. Ruediger, O.; Hirschfeld, D.; Hoffman, A.; (and others) (Fried-Krupp GmbH, Essen). Tech. Mitt. Krupp, Forschungsber.; 29: No. 1, 1-14 (May 1971). (In German).

Chemical analysis and radiographic inspection were carried out of the auxiliary metal phase in tungsten carbide–cobalt alloys after electro-chemical isolation. There was a correlation between the composition of auxiliary metal and the cobalt and/or carbon content of the alloys. Initial grain size of the tungsten-carbide, sintering and cooling conditions, and bending strength were studied. Tensile strength, 0.2 proof stress, elongation at fracture, and reduction of area of cobalt-tungsten-carbon alloys were studied as functions of the composition. (auth)

45123 OXYGEN REDUCTION ON TUNGSTEN CARBIDE. Voinov, M.; Buehler, D.; Tannenberger, H. (Inst. Battelle, Carouge, Switzerland). J. Electrochem. Soc.; 118: No. 7, 1137-8(Jul 1971).

The exchange current for oxygen reduction on tungsten carbide was found to 10^{-9} A/cm². It was obtained by extrapolation to 1.23 V on the E (log i) curve. (G.M.C.)

45124 VAPORIZATION THERMODYNAMICS OF THE LANTHANUM–CARBON SYSTEM: MASS-SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF LaC_2, LaC_3, AND LaC_4. Stearns, Carl A.; Kohl, Fred J. (Lewis Research Center, Cleveland). J. Chem. Phys.; 54: No. 12, 5180-7 (15 Jun 1971).

The vaporization of the lanthanum dicarbide–carbon system was studied by Knudsen-effusion mass spectrometry over the temperature range from 2267 to 2600°K. Experimentally determined reaction enthalpies were combined with published thermodynamic data to yield the atomization energies $D^0_{0,atom}(LaC_2) = 1257 \pm 8$ kJ mole^{-1}, $D^0_{0,atom}(LaC_3) = 1759 \pm 31$ kJ mole^{-1}, and $D^0_{0,atom}(LaC_4) = 2500 \pm 16$ kJ mole^{-1}. Ion intensities of the parent molecular ions La^+, LaC_2^+, LaC_3^+, and LaC_4^+ were combined with absolute effusion measurements from the literature to obtain vapor pressure equations (1900 – 2600°K): $\log P_{La} = (-2.606 \times 10^4/T) + 10.162$, $\log P_{LaC_2} =$

$(-3.327 \times 10^4/T) + 12.813$, $\log P_{LaC_3} = (-4.414 \times 10^4/T) + 14.557$, and $\log P_{LaC_4} = (-4.301 \times 10^4/T) + 15.067$, where the units of pressure are newtons per square meter. (auth)

45125 DIFFUSION AND SOLUBILITY OF HYDROGEN IN URANIUM DIOXIDE SINGLE CRYSTALS. Wheeler, V. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 40: No. 2, 189-94(Aug 1971).

The diffusion of hydrogen has been measured in UO_2 single crystals in the temperature range 500 to 1000°C by vacuum-extraction and tritium tracer measurements. The data are fitted by the equation: $D = 0.037 \exp -(14300 \pm 900$ calories/RT)cm^2/s. The solubility of hydrogen varies between 0.03 to 0.4 μg H_2/g UO_2, depending upon the defect structure of the UO_2 crystal. (auth)

45126 DISPERSED-PARTICLE STRENGTHENING IN NICKEL–ZIRCONIA COMPOSITE MATERIALS AT LOW TEMPERATURES. Prasad, Y. V. R. K.; Sastry, D. H.; Vasu, K. I. (Indian Inst. of Science, Bangalore). pp 52-63 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

The deformation behavior of ZrO_2-Ni dispersions was studied at 87°K. It was found that the initial density of dislocations is higher in dispersed alloys than in pure nickel. The yield stress in zirconia-dispersed nickel was found to be dictated by the initial dislocation density in addition to the resistance offered by particles to dislocation motion. Strain hardening may result from the increase in dislocation density in the vicinity of the particles. The rate-controlling mechanism for deformation of dispersion-strengthened alloys of zirconia in nickel is the thermally activated intersection of dislocations. (auth)

45127 THERMAL DIFFUSIVITY AND CONDUCTIVITY OF ZIRCONIUM CARBIDE AND NIOBIUM CARBIDE FROM 100 TO 2500°K. Morrison, B. H.; Sturgess, L. L. (Los Alamos Scientific Lab., N. Mex.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 351-8(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-70031.

The thermal diffusivity of two hot-pressed metal carbides, ZrC and NbC, was measured from 100 to 2500°K by the laser flash technique. The front surface of thin sample discs was thermally pulsed by a neodymium glass laser and the transient time–temperature response of the back surface was measured electrically by thermocouple probes from 100 to 1300°K and optically by a photomultiplier tube from 1100 to 2500°K. Repeated measurements on duplicate samples demonstrated a precision of ±5%. The accuracy of the laser flash technique was estimated at ±7% by comparison with published thermal diffusivity measurements on Armco iron. Curves of thermal diffusivity versus temperature for both carbides exhibited negative slopes from 100 to 400°K, broad minima from 400 to 600°, and then a gradual positive slope up to the maximum test temperature. (France)

45128 APPLICATIONS OF HIGH TEMPERATURE DATA IN INDUSTRY. WITH ESPECIAL REFERENCE TO NON-METALLIC MATERIALS. Hill, N. A.; White, A. E. (Morganite Research and Development, Stourport on Severn, Eng.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 402-9(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

The manufacture of ceramic materials for high-temperature applications has evolved over a number of years, and materials with satisfactory lives for use in corrosive environments in the temperature range 700 to 1800°C are now available. Experience shows that any reactions predicted by the thermodynamics of the system can be expected to proceed rapidly to completion. When a material (or group of materials) is selected on chemical and thermodynamic grounds, the thermophysical properties are very important as they are related to the service life and limiting conditions as well as having an effect on eventual failure mechanisms. The use of heterogeneous ceramic materials demonstrated the need for thermophysical data on multiphase materials. In particular the interaction of thermal conductivity, emissivity, and high-temperature chemical resistance are discussed. (France)

45129 FOURTH AUSTRALIAN CERAMIC CONFERENCE PROCEEDINGS, CLAYTON, VICTORIA, AUSTRALIA, 18th-20th AUGUST, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970). $11.10. (CONF-700841).

A separate abstract was prepared for each of the five papers presented at the conference that was considered to be in the scope for NSA. (J.R.D.)

For abstracts of individual papers see: 45111, 45112, and 45130–45132.

45130 SOME WEAR-RESISTANT CERAMIC MATERIALS. McKinnon, N. A.; Stringer, R. K.; Williams, L. S. (Commonwealth Scientific and Industrial Research Organization, Melbourne). pp AB1.1-8 of Fourth Australian Ceramic Conference Proceedings, Clayton, Victoria, Australia, 18th–20th August, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970).

From fourth ceramic conference; Clayton, Victoria, Australia (18 Aug 1970). See CONF-700841.

Relations of microstructure and thermal expansion properties of zirconia hot extrusion die materials with observed service life were investigated. Zirconia partially stabilized with magnesia is less sensitive to thermal shock than the fully stabilized form. The service life of zirconia dies exceeds that of cobalt dies and its use in extrusion of metals having high mp or reactivity is advantageous despite the higher cost of zirconia. Development of single-phase compositions stabilized with Y_2O_3 or Sc_2O_3 is described for successful application in a soda recovery plant. Applications to control of microstructural phase distribution, fiber-strengthening, and crack-reducing techniques are anticipated. Development of a $B_4C-MoSi_2$ composition for test nozzle fabrication is described. (Australia)

45131 CREEP OF STABILIZED ZIRCONIA. Bailey, F. P. (Commonwealth Scientific and Industrial Research Organization, Melbourne). pp AB12.1-5 of Fourth Australian Ceramic Conference Proceedings, Clayton, Victoria, Australia, 18th–20th August, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970).

From fourth ceramic conference; Clayton, Victoria, Australia (18 Aug 1970). See CONF-700841.

Compressive creep behavior in zirconia stabilized by yttria was examined, with respect to the size of the stabilizing trivalent cation. Deformation behavior of compacted $ZrO_2-9.12$ wt % $Y_2O_3-0.6$ wt % Dy_2O_3 specimens was evaluated over the range 1400 to 1535°C and 1000 to 9000 psi, using differential and conventional creep tests. Microstructural examination of specimens was carried out at all levels of deformation. A diffusion creep mechanism is indicated by the coincidence of deduced experimental activation energies (110 kcal/mole) with self-diffusion results of the Zr cation. Voids formed perpendicular to the effective tensile stresses are attributed to accommodation kinetics at grain boundary triple points and other immobile microstructural features. (Australia)

45132 THERMAL DECOMPOSITION OF UO_3 HYDRATES. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp AB13.1-2 of Fourth Australian Ceramic Conference Proceedings, Clayton, Victoria, Australia, 18th–20th August, 1970. Melbourne; Commonwealth Scientific and Industrial Research Organization (1970).

From fourth ceramic conference; Clayton, Victoria, Australia (18 Aug 1970). See CONF-700841.

Single crystals of the monohydrates α and $\beta-UO_2(OH)_2$ were heated in dry argon at 5°C/min. Decomposition began in the range 300 to 400°C with the α form beginning first and decomposing to $\alpha-UO_3$ to $UO_{2.9}$ to U_3O_8. The β form decomposed first to a mixture of $\alpha-UO_3$ and $\delta-UO_3$ in roughly equal proportions, then to $UO_{2.9}$ to U_3O_8. All products showed a high degree of preferred orientation, and layer plane alignments and shrinkage are described. Since the layer structure of ADU is similar to that of $\alpha-UO_2(OH)_2$ it is predicted that decomposition of ADU will result, at least initially in only minor rearrangements of atoms within the layer planes. Extensive interlayer cracking is partially removable by sintering at higher decomposition temperatures. (Australia)

Structure and Phase Studies

Refer also to abstracts 44457, 45528, and 45611.

45133 METALLOGRAPHY OF ZIRCONIUM HYDRIDE PHASES. Paetz, Peter; Mueller, Balthasar (INTERATOM, Bensberg, Ger.). Prakt. Metallog.; 8: No. 5, 272-8(May 1971). (In German and English).

A brief survey of the equilibria of the zirconium hydride phases as shown in an equilibrium diagram is presented. A detailed description is given of the preparation of metallographic surfaces to reveal the various phases by etching. Both the identification of α-zirconium and the three hydrides, γ, δ and ϵ, using the optical microscope, and the application of optical microscopy to determine hydrogen in zirconium hydride are discussed. (auth)

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45134 MICROSTRUCTURE OF HOT-PRESSED MOLYBDENUM CARBIDE. Koval'chenko, M. S.; Rogovo, Yu. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 1013-17(Dec 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 72-7(Dec 1970).

A study was made of the effect of temperature on the mean size, density, and type of distribution of grains in the hot pressing of molybdenum carbide. Raising the hot-pressing temperature in the range 1900 to 2200°C at constant process pressure and time is accompanied by an appreciable growth in the mean size of Mo_2C grains. At the same time, both the symmetry of grain size distribution and the grain size spectrum increase. The energy of activation for the growth of Mo_2C grains, which was found to be 49 ± 3 kcal/mole, characterizes collective recrystallization for pressing under the conditions employed. (auth)

45135 SYSTEMS HAFNIUM–TUNGSTEN–BORON, HAFNIUM–RHENIUM–BORON, AND NIOBIUM–RHENIUM–BORON. Kuz'ma, Yu. B.; Lakh, V. I.; Stadnyk, B. I.; Kovalyk, D. A. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 1003-6(Dec 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 59-63(Dec 1970).

The reactions of two refractory transition metals with boron were investigated. The study of the ternary systems Hf–W–B, Hf–Re–B, and Nb–Re–B was based on the available literature data on the binary systems Hf–B, W–B, Hf–W, Re–B, Hf–Re, Nb–B, and Nb–Re. The ternary systems mentioned above have never been examined before. Specimens for investigation were prepared from Hf (99.5%), W (99.98%), Re (99.7%), Nb (99.7%), and B (99.3%) powders. After thorough mixing, charge materials were pressed into compacts and melted in an electric arc furnace with an argon atmosphere. The compositions of the materials were checked by weighing; specimens showing weight discrepancies of more than 2% were scrapped and new specimens were prepared; spot chemical analyses of specimens confirmed that this method of control gave satisfactory results. The following annealing treatments, performed in a vacuum furnace, were employed: 50 hr at 1400°C for the system Hf–W–B, 100 hr at 1500°C for the system Hf–Re–B, and 60 hr at 1400°C for the system Nb–Re–B. After annealing, the specimens were furnace-cooled at a rate of 20°C/sec. The resultant specimens were subjected to x-ray structural analysis by the powder method (camera diameter 57.3 mm, Cr–K radiation). (auth)

45136 PHASE COMPOSITION OF THE SYSTEM V_2O_5–TiO_2. Sterligova, G. I.; Kaprovich, V. V.; Anufrienko, V. F.; Kurina, L. N. (Tomsk State Univ., USSR. Inst. of Catalysis, Novosibirsk). Kinet. Katal.; 12: No. 1, 255-7(Jan-Feb 1971). (In Russian).

The phase composition of vanadium oxide catalysts was studied by means of electron paramagnetic resonance and by x-ray diffraction patterns. Hydrated TiO_2 gel was mixed with NH_4VO_3 and calcined at 500, 600, and 740°C for periods of from 5 to 14 hr in order to produce V_2O_5–TiO_2 specimens. Samples of V_2O_4–TiO_2 were prepared by heating mixtures of these oxides at 900 to 1000°C for 5 hr. The spectrum of V^{-4} ions was detected, its intensity varying with the composition. The presence of a chemical compound or solid solution of the components could not be detected. (K.S.W.)

45137 PHASE STUDIES IN THE SYSTEM $Fe_xCa_{1-x}Nb_2O_6$. Deshpande, V. V.; Darshane, V. S.; Rao, K. Rama (Inst. of Science, Nagpur, India). Curr. Sci. (India); 40: No. 13, 345-6(5 Jul 1971).

Columbite ($FeNb_2O_6$), fersmite ($CaNb_2O_6$), and the intermediate compositions were prepared. X-ray analysis was used in order to study the phases developed during the substitution of Fe^{2+} by Ca^{2+}. The lattice parameters of various phases are given. (G.M.C.)

45138 DISSOCIATION OF j-UO_3. Bessonov, A. F. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 102-4(1971). (In Russian).

The most stable modification of UO_3 at high temperatures is the j-form. Using a technique of simultaneous observations of electrical resistance, a thermogram, linear dimensions of the sample, and the change in the intensity of the characteristic line $2\theta = 34°$, and a heating gradient of 6°C/min, a sample of j-UO_3 underwent the following phase transformations: j-UO_3 $\xrightarrow{>580°C}$ solid solution of chiefly U_3O_{8+x} $\xrightarrow{650°C}$ α-U_3O_8 $\xrightarrow{>850°C}$ hexagonal modification of the oxide $\xrightarrow{>1050°C}$ U_3O_{8-x}. (K.S.W.)

45139 SOLUBILITY OF BORON IN NIOBIUM IN THE SOLID STATE. Pshokin, V. P.; Zakharov, A. M.; Novikov, I. I. (Moscow Inst. of Steels and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 111-14(1971). (In Russian).

The Nb side of the binary system Nb–B was investigated up to 5.4% B, utilizing mp characteristics, and microscopic and x-ray examinations of cast and strained alloys which were quenched from various temperatures after prolonged annealing. A eutectic was noted: α–Nb_3B_2 (where α represents a solid solution of chiefly Nb), mp 2170°C, and containing about 1.6% B. The maximum solubility of B in Nb near the eutectic mentioned above was 0.35% (2170°C). At 1950, 1600, and 1200°C, the B solubility was 0.26, 0.15, and 0.05%, respectively. This may be described by the equation: ln (B content in atom %) = 4.15 – (7.5 × 10^3)/T°K. (K.S.W.)

45140 CRYSTAL STRUCTURE OF THE HIGH-TEMPERATURE FORM OF Ta_2O_5. Stephenson, N. C.; Roth, R. S. (National Bureau of Standards, Washington, D. C.). J. Solid State Chem.; 3: No. 2, 145-53(May 1971).

The structure of the high-temperature form of Ta_2O_5 can be stabilized by doping with 2 mole % Sc_2O_3 and single crystals have been prepared from a Ta_2O_5–Sc_2O_3 (98 : 2) composition by the Czochralski technique. The crystal system, which at first appeared to be body-centered tetragonal, has been determined to be face-centered monoclinic, space group C2 with a = 35.966 Å, b = 3.810 Å, c = 3.810 Å, β = 96°7'. Least-squares refinement cycles reduced the reliability index R to 0.089. The structure consists of αUO_3-type blocks in which each tantalum atom is surrounded by a pentagonal bipyramid of oxygen atoms. These blocks are infinite in two directions and are separated from similar blocks along a third direction by shear planes. In the vicinity of these shear planes the tantalum atoms are surrounded by distorted octahedral coordination polyhedra. It is believed that the stabilizing effect of the Sc_2O_3 impurity is due to an increase in the concentration of shear planes. Random shear planes (Wadsley defects) are introduced at approximately 300 Å intervals along the large axis by doping with a substance (Sc_2O_3) which has cations (Sc) large enough to substitute for the host (Ta) but a lower oxygen: metal ratio than the host compound (Ta_2O_5). (auth)

45141 EFFECT OF ANNEALING ON THE CONCENTRATION OF WADSLEY DEFECTS IN THE Nb_2O_5–WO_3 SYSTEM. Allpress, J. G. (Univ. of Melbourne); Roth, R. S. J. Solid State Chem.; 3: No. 2, 209-16(May 1971).

Mixtures of $xNb_2O_5 \cdot yWO_3$ with x : y = 9 : 8, 8 : 5, and 8 : 1 have been annealed at high temperatures for prolonged periods before quenching to room temperature. The concentration of Wadsley defects, estimated from lattice image electron micrographs of a few fragments in each sample, is reduced during this treatment. The results indicate that (1) the high-temperature equilibrium is attained very slowly, and in stoichiometric samples probably involves the complete removal of Wadsley defects; (2) the high-temperature situation is not seriously affected by the quenching treatment; and (3) variations in stoichiometry may be accommodated by means other than the presence of Wadsley defects. (auth)

45142 PHASE INTERVAL $PrO_{1.50}$ TO $PrO_{1.71}$ IN THE PRASEODYMIUM OXIDE–OXYGEN SYSTEM. Turcotte, Rheal P.; Warmkessel, Joyce M.; Tilley, Richard J. D.; Eyring, Leroy. (Arizona State Univ., Tempe). J. Solid State Chem.; 3: No. 2, 265-72(May 1971).

Phase relationships and phase transitions in the composition region $PrO_{1.50}$–$PrO_{1.71}$ have been studied by x-ray diffraction analysis on quenched samples and in situ at high temperatures. An interpretation of the results is given in terms of a metastable set of phases including C-form Pr_2O_3 below 910°C and a stable set including A-form Pr_2O_3 above that temperature. Besides these two polymorphic sesquioxides and the oxygen-rich end member, Pr_7O_{12}, a widely nonstoichiometric phase and a phase of approximate composition $PrO_{1.67}$ have been identified. Thermal expansion measurements have been made on C-form Pr_2O_3 and Pr_7O_{12}. Hysteresis is clearly indicated by the high-temperature x-ray studies. These results are contrasted with those of recently published high-temperature emf studies in this composition region. (auth)

45143 FIELD ION MICROSCOPY OF GRAPHITE FIBERS. Murr, L. E.; Inal, O. T. (Univ. of Southern California, Los Angeles). J. Appl. Phys.; 42: No. 9, 3487-93(Aug 1971).

Field ion microscopy of pyrolytic graphite produced image streaks resulting from gross surface irregularities as a result of the etching characteristics in tip preparation. The streaks were observed to contract with a decrease in imaging voltage and to remain relatively stable. Commercial high-modulus graphite fibers could be electropolished to fine tips, and single-image points (occurring as double spots) were observed for the first time in the field-ion microscope. These image points were interpreted to represent the carbon atoms in the corner of a single graphite platelet. It is concluded from these experiments that the possi-

bility of studying graphite by field-ion microscopy might be viewed with a little more optimism. (auth)

45144 HIGH TEMPERATURE URANIUM CARBIDE/SILICON CARBIDE REACTION: A STRUCTURAL DEPENDENCE. Walker, D. E. Yeoman; Bradshaw, R. P.; Shaw, E. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Nucl. Mater.; 40: No. 2, 221-4(Aug 1971).

Results of investigations are presented which show that the structure of pyrolytic SiC has a marked effect on reactions between UC and SiC. Perhaps the extensive reaction in columnar SiC is connected with the fact that easy radial paths via grain boundaries are available for the (molten) U/Si phases to move outwards, whereas columnar-cell spheres of SiC, having prominent circumferential layers, do not provide similar radial paths. It appears more likely that the layers provide sinks for the retardation of the onward moving uranic front. (J.R.D.)

45145 STABILIZATION OF URANIUM CARBONITRIDES (N ≤ 1 WT. %) BY TUNGSTEN ADDITION. Ugajin, M. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 40: No. 2, 175-88(Aug 1971).

Experiments have been performed to study the effect of W additions (2 to 7 wt %) on the structural and thermal behavior of uranium carbonitrides with low nitrogen contents (≤1 wt %). The carbonitrides with and without W additions were prepared by arc-melting the elements (C/U < 1) under Ar + N_2 atmospheres. The products were examined by ceramography, x-ray diffraction, and electron-microprobe analysis. Single-phase U(C, N) with given concentration can be produced under essentially only one N_2 partial pressure; pressures higher than this lead to formation of a parasitic phase UC_2. W reacts with the UC_2 during arc-melting to form stable compound UWC_2. Thus its addition to the feed materials extends the limits of the N_2 pressure and the starting C/U ratio at which U(C, N) without U metal and UC_2 can be prepared. The structurally stabilized carbonitride [$UC_{1-x}N_x$ (x = 0.10 − 0.18) + UWC_2 and/or W] exhibits better thermal stability at 1900°C than $UC_{0.89}N_{0.11}$ with no W addition; the latter decomposes to give molten U and N_2 gas under a dynamic vacuum of ≈10^{-6} torr. For comparison purpose additions of Mo and Cr were also made. (auth)

45146 DEFECT STRUCTURE AND IONIC CONDUCTIVITY OF ZIRCONIA AND THORIA. Subbarao, E. C.; Chaudhary, C. B.; Mehrotra, A. K.; Patil, R. N. (Indian Inst. of Tech., Kanpur). pp 429-35 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Results of x-ray diffraction studies of sintered specimens of $ZrO_2-Y_2O_3-Nb_2O_5$ and ThO_2-CaO are presented. Phase identification of compounds in these systems was made and lattice parameters were computed. (J.R.D.)

45147 INFLUENCE OF MICROSTUCTURE ON THE PROPERTIES OF CERAMIC PRODUCTS. Rao, S. V. K.; Moorthy, V. K. (Bhabha Atomic Research Centre, Bombay). pp 219-29 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24-27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.2).

A review of ceramics is presented which shows that ceramic products cover a wide range of applications. The properties of the materials depend on the microstructural features of the products. Room temperature properties are mainly dependent on the porosity and the nature of the ceramic bonds. High temperature properties are mainly governed by the properties of the glassy phases in refractories. In the case of single phase ceramics, most of the properties are sensitive to the density and structure; a special mention can be made of electric and magnetic properties which are found to be more sensitive to the microstructure. Though the general trends in the relation between structure and properties are known, their exact inter-relationships are not yet established. At this stage of technology, if the end-properties and service requirements are clearly known, products can be developed to meet such requirements. (auth)

Radiation Effects

Refer also to abstracts 44487, 45536, and 45552.

45148 (AEC-tr-7238) CONTINUOUS MEASUREMENT OF THE CREEP OF UO_2 UNDER IRRADIATION. Brucklacher, D.; Dienst, W. Translated from J. Nucl. Mater.; 36: 244-7(1970). 6p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 4893.

45149 (HEDL-SA-71) RESTRUCTURING EFFECTS ON OXIDE FUEL TEMPERATURE DISTRIBUTIONS. Lawrence, L. A.; Christensen, J. A. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 12p. (CONF-710606-8). Dep. NTIS.

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

An irradiation experiment that was conducted to determine the effects of restructuring on the melting heat rating of mixed-oxide fuels is described. The experiment consisted of irradiating simultaneously two fuel pins positioned axially in a large diameter aluminum sleeve. Fuel surface temperatures were calculated and the uncertainty estimated to be ±50°C for Pin A and ±100°C for Pin B. Results of the experiments show that for initially 95% dense fuel the increase in melting heat rating due to densification and restructuring in the fuel could be no more than 3%, and for fuel pins with large initial fuel-clad gaps in considering enhanced heat rating capabilities due to restructuring, the effects of decreased gap width on heat transfer across the fuel-clad gap must be considered. (auth)

45150 (JUL-749-RW) STRESS ANALYSIS FOR COATED PARTICLES TO HIGH-FAST DOSE VALUES. COMPARISON BETWEEN CALCULATIONS AND TEST RESULTS. Bongartz, K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Apr 1971. 25p. Dep. NTIS (U. S. Sales Only).

Stress calculations were performed for coated fuel particles that were irradiated to a very high fast dose in the Dounreay fast reactor with practically no burnup. The results of the calculations were compared with the test results. As in this case burnup was negligible; a more detailed investigation of the fast dose induced mechanisms only, contributing to the particle behavior was possible. The dose induced unrestrained dimensional changes of the high-density isotropic pyrocarbons (PyC − HDI) being very important input data for the model of several sets of these curves given by various authors that were used for the calculations. One particular set was found to give results in stress calculations which were in rather good agreement with the test results. The calculations fitted the test results as far as the various irradiation temperatures and densities of the material which were investigated are concerned. It appears probable that the very pronounced dependence of particle behavior on the bacon anisotropy factor (BAF) of the PyC − HDI can be taken account of in the stress model via the dose induced dimensional changes which appear to depend strongly on the BAF. The comparison between calculations and test results gave some evidence for mechanisms which probably led to failure of particles with a silicon carbide (SiC) interlayer in the test. (auth)

45151 EFFECT OF NEUTRON RADIATION ON THE PROPERTIES OF SOME METALLO-CERAMIC ANTIFRICTION MATERIALS. Fedorchenko, I. M.; Markovskii, E. A.; Tikhonovich, V. I.; Pushkarev, V. V.; Kirievskii, B. A. (Inst. of Material Handling Problems, Kiev. Inst. of Casting Problems, Kiev.). Fiz.-Khim. Mekh. Mater.; 7: No. 1, 78-81(1971). (In Russian).

The effects of neutron radiation at a flux of 10^{19} n/cm^2 on the hardness, coefficient of friction, and wear resistance of metallo-ceramic materials with an iron base were investigated. As a result of such irradiation, the hardness increased; the coefficient of friction and the wear resistance varied depending upon the identity of the alloying element which had been previously introduced into the composition of the material. The various compositions tested were: porous iron, Fe impregnated with S, Fe-graphite, Fe − ZnS, Fe − CuS, Fe − graphite − Cu, and babbitt metal. (tr-auth).

45152 EFFECT OF FAST NEUTRON IRRADIATION ON THE STRUCTURE AND MECHANICAL PROPERTIES OF A HIGH MODULUS GRAPHITE FIBER. Jones, B. F.; Peggs, I. D. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). J. Nucl. Mater.; 40: No. 2, 141-50(Aug 1971).

The effect of fast neutron irradiation at 420 and 500°C on the structure and mechanical properties of RAE type, high modulus graphite fibers is reported and discussed. The tensile strength of the fibers was decreased from 251 × 10^3 psi to 206 × 10^3 psi, and their Young's modulus from 47.6 to 39.8 × 10^6 psi by a fluence of 4.8 × 10^{20} n/cm^2 (E > 1 MeV) at 420°C. A similar reduction in these properties was observed after exposure to only 2 × 10^{17} n/cm^2 (E > 1 MeV) at 500°C. These changes are explained in terms of the structural degradation of the fibers which occurs during irradiation. (auth)

45153 TRANSMISSION ELECTRON MICROSCOPY OF U_3Si-EFFECT OF IRRADIATION. Bethune, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 40: No. 2, 205-12(Aug 1971).

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A prominent feature of many U_3Si samples is the micro-twinned structure observed in optical and electron micrographs. Microtwins are destroyed by irradiation below 100°C to 6.17×10^{16} fissions/cm^3; the absence of dark field images indicates that an amorphous state has been formed where areas of atomic order are ≤20 Å in diameter. Annealing at 350°C returns the crystallinity and grains with diameter about 140 Å are resolved. Grain growth occurs with increased annealing temperature and the polycrystalline structure is again dominated by microtwins after annealing at 800°C. The unaccounted volume increase of 2.4% which occurs in U_3Si irradiated under similar conditions might be explained in terms of vacancy clusters at ≤20 Å, a size that is less than can be resolved by the microscopic technique used. (auth)

Plastics and Other Materials

Refer also to abstracts 44477, 44497, 45551, and 45555.

45154 (EUR–4333) STUDIES ON COMPACTED AND NON-COMPACTED REACTOR GRAPHITE USING GAS DIFFUSION AND SORPTION MEASUREMENTS. Gottlieb, R. P. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 152p. (In German). NTIS (U. S. Sales Only).

Using ^{85}Kr gas diffusion and sorption measurements reactor graphite was investigated for the purposes of characterizing the texture of ceramic materials. Results show that for both types of graphite investigated the open porosity decreased distinctly from the starting material to the highly compacted sample. The fraction of the accessible pores in the overall porosity was thus reduced. The specific surface area first increased slightly for increasing compaction as a result of the inclusion of the fine impregnating agent but then dropped to well below the starting value. Results of the experiment on the effect of the impregnation on the texture of the graphite show that as a result of the compacting, porous plugs are formed on the narrow parts of the pores, often through irregular deposition of the impregnating agent. As the compacting increases, these become impermeable to gases as the result of further deposits and a considerable proportion of the pores are closed by walling up. (D.H.M.)

45155 (EUR–4334) TRACE IMPURITIES IN REACTOR GRAPHITE. Merz, E.; Riedel, H. J. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 14p. (In German). NTIS (U. S. Sales Only).

Analyses were carried out to decide the trace impurity content of nine different types of graphite which can be contemplated for use in the manufacture of spherical fuel elements for a thorium high-temperature reactor. This analysis concerned only those elements which create perturbing radioactivities as a result of neutron activation. These activity values are absolutely essential when making corrections (subtraction of so-called reactive values) in fission product distribution investigations. They can also serve, however, as a quality indicator. The reactor graphites produced by the different firms all contain virtually the same trace impurities; there are considerable differences, however, with regard to the absolute content in each case. (auth)

45156 SOME PECULIARITIES OF RADIATION CREEP AND DURABILITY OF POLYMERS. Stepanov, V. F.; Vaisberg, S. E.; Karpov, V. L. Fiz.-Khim. Mekh. Mater.; 7: No. 1, 65-70(1971). (In Russian).

It is shown that relaxation processes do not affect the rate of radiation creep which is assignable to breakage of strained chemical bonds. Radiation stability of oriented polymers is greater than non-oriented. Polymer film thickness does not effect the radiation creep rate. Reasons are outlined for the inconstancy of the effect of fixed creep rate on durability. (tr-auth)

45157 EFFECT OF RADIATION ON THE MECHANICAL PROPERTIES OF POLYETHYLENE FILMS OF LOW DENSITY. Glukhovskaya, G. I.; Nikitskii, A. V.; Zhikharev, V. S.; (and others). (Inst. of Physical Chemistry, Kiev. Physico-Mechanical Inst., Lvov). Fiz.-Khim. Mekh. Mater.; 7: No. 1, 70-3(1971). (In Russian).

The effects of radiation and subsequent thermal cycling of polyethylene low-density film on its physical and mechanical properties were investigated. The optimal conditioning process was established for markedly promoting the stability of the material. (tr-auth)

45158 EFFECTS OF EDGE LOSSES ON THE THERMAL CONDUCTIVITY OF THERMAL INSULATIONS AT HIGH TEMPERATURE. Tye, R. P. (Dynatech R/D Co., Cambridge, Mass.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 308-12(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

Measurements of the effects of edge losses on the thermal conductivity of some thermal insulations were made at high temperatures by the hot plate method. A standard single guard ring plate was used with an additional outer cylindrical guard. The temperatures of this guard could be adjusted over a wide range in order to vary the edge temperature of the sample and to examine whether a theoretical expression derived by Woodside was applicable at high temperatures. It was found that significant errors could occur unless the limits imposed on the expression were reduced and that these errors were largest for materials of low thermal conductivity. (France)

PHYSICS (GENERAL)

Astrophysics and Cosmology

45159 TRANSFER OF POLARIZED LIGHT IN RAYLEIGH-SCATTERING HALF SPACES WITH TRUE ABSORPTION. Schnatz, T. W.; Siewert, C. E. (North Carolina State Univ., Raleigh). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 491-508(1971).

The singular-eigenfunction-expansion technique, often employed for studies in neutron transport theory, is used to introduce a general solution to the vector equation describing the transfer of polarized light in a Rayleigh-scattering atmosphere with true absorption (imperfect scattering). Two discrete eigenvectors and two linearly independent, degenerate, continuum eigenvectors are presented and form the basis for subsequent analysis which is directed primarily towards the construction of solutions to typical half-space problems. The eigenvectors are used to establish a singular integral equation and a linear integral constraint necessary and sufficient to specify the required H-matrix, a generalization of Chandrasekhar's H-function. Further, the analysis yields the nonlinear integral equation, previously derived from the classical principles of invariance; this nonlinear equation and the linear constraint are also shown to be sufficient to specify the H-matrix and are used for computational purposes. After the general formalism is established, the method is used to construct complete solutions (valid at any optical depth) to the half-space albedo problem and the classical Milne problem. These solutions are written explicitly in terms of the normal modes, and all unknown expansion coefficients are then expressed in terms of the H-matrix. To illustrate the computational merits of the analysis, highly accurate numerical results for the half-space albedo and the Milne-problem extrapolated end-point are presented for a representative set of values of the single-scattering albedo. (auth) (UK)

Cosmic Ray Exposure Ages

45160 (JINR-E15-5800) IMPLICATIONS OF THE HYPOTHESIS OF EXTINCT FISSIONING ISOTOPE IN THE PRIMITIVE METEORITES. Dakowski, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 12p. Dep. NTIS (U. S. Sales Only).

It is shown that if the carbonaceous chondrite xenon anomaly was really caused by fission, then its progenitor was the most long-lived isotope of the superheavy elements with a half-life of 2×10^6 to 6×10^7 yr. In this case the search for superheavy elements synthesized prior to the formation of the solar system would be fruitless. (auth)

45161 ISOTOPIC COMPOSITION OF GADOLINIUM, SAMARIUM, AND EUROPIUM IN THE ABEE METEORITE. Loveless, Arthur John. Vancouver, British Columbia; Univ. of British Columbia (1970). National Library of Canada, Ottawa. Thesis.

The isotopic composition of gadolinium, europium, and samarium was measured in the Abee meteorite and in two terrestrial ores. Isotopic analyses were performed on microgram quantities of Gd, Eu, and Sm. A precision of 0.02 to 0.2% (at the 95% confidence level) was achieved for all isotopic ratios of interest. Prior to 1970 the best published isotopic analyses of these elements had a precision of 1 to 2%. The higher precision was made possible through improvements in the mass spectrometer ion optics and the use of digital recording of mass spectra. This work is comparable to recent meteorite analyses on Gd by Eugster, Tera, Burnett, and Wasserburg, although their lunar analyses were of superior quality and had a precision of 0.01%. No significant Gd, Eu, or Sm isotopic anomalies were observed for the Abee and terrestrial samples. The $^{157}Gd/^{158}Gd$ ratio, which is the most sensitive to neutron irradiation, was identical for the three samples studied within 0.1%. This places an upper limit of 3×10^{15} neutrons/cm^2 for the differential irradiation of the source material from which the Earth and the Abee meteorite were derived. A similar conclusion was reported by the Caltech group. The absence of any anomalies may be attributed to uniform irradiation and dilution of the source material, efficient shielding inside large planetary bodies during the irradiation phase, the absence of an intense irradiation phase, or a common spatial origin within the solar nebula for chondritic and terrestrial matter. (TSS) (Diss. Abstr. Int., B)

45162 STATISTICAL MECHANICS OF LIGHT ELEMENTS AT HIGH PRESSURE. I. THEORY AND RESULTS FOR METALLIC HYDROGEN WITH SIMPLE SCREENING. Hubbard, W. B.; Slattery, Wayne L. (Univ. of Texas, Austin). Astrophys. J.; 168: No. 1, 131-9(15 Aug 1971).

A numerical algorithm for calculating the thermodynamic state variables of light elements at multimegabar pressures and a wide range of temperatures are presented. The technique uses linear-response (dielectric function) theory to calculate the electron-density distribution as a function of ion configuration, and ensemble averages are evaluated by the use of Monte Carlo chains. A number of results are presented for liquid metallic hydrogen at densities of 2.679 and 2679 g cm^{-3} and temperatures ranging from 313000° to 4170°K. (auth)

45163 FOSSIL PARTICLE TRACKS IN EXTRA-TERRESTRIAL MATERIALS. Walker, R. M. (Washington Univ., St. Louis). pp VII.2-25 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

After reviewing the current state of knowledge for meteorites, the study of tracks in lunar samples is considered. New kinds of tracks, yielding completely new kinds of physical information can be expected. Perhaps the greatest promise is the possibility of tracing out the past history of solar activity. (France)

45164 DISCOVERY OF AN EARLY IRRADIATION OF METEORITE CRYSTALS USING SCANNING ELECTRON MICROSCOPY. Poupeau, G.; Pellas, P.; Lorin, J. C. (Museum National d'Histoire Naturelle, Paris. CNRS, Paris). pp VII.26-40 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Heavy-ion tracks recorded in meteoritic crystals (from Kapoeta and Jodzie howardites) were studied using scanning electron microscopy. Track densities measured by this method are shown to be the same as those observed with high-magnification optical microscopy. Specific techniques for track revelation in crystals are given as well as criteria for track identification. Improved resolution gives more information on characteristics of the low-energy particle irradiation found recently in dark portions of gas-rich meteorites. This low-energy particle flux (in the MeV/n range) is thought to have been registered in pyroxene crystals ≃4.5 b.y. ago and to be of solar origin. (auth) (France)

45165 NUCLEAR INTERACTION TRACKS IN MINERALS AND THEIR IMPLICATIONS FOR EXTRATERRESTRIAL MATERIALS. Crozaz, G.; Hair, M.; Maurette, M.; Walker, R. (Washington Univ., St. Louis). pp VII.41-54 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The geometrical characteristics and the thermal stability of the interaction tracks by protons and α particles in mica and also in minerals found in meteorites or which are likely to be found in lunar materials were studied. The energy and the fluxes of the ions were chosen to simulate exposures of >10^3 years in the light component of solar-flare cosmic rays. This study is the first part of a general survey that should help to predict the characteristics of the track distribution that can be expected from an exposure of meteoritic or lunar materials to solar cosmic rays. (auth) (France)

45166 ACCELERATOR IRRADIATIONS OF MINERALS: IMPLICATIONS FOR TRACK FORMATION MECHANISMS AND FOR STUDIES OF LUNAR AND METEORITIC MATERIALS. Seitz, M. (Washington Univ., St. Louis); Wittels, M. C.; Maurette, M.; Walker, R. M.; Heckman, H. pp VII.55-67 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6-9, 1969. Vol. 2. /Isabelle D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

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From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Natural crystals of feldspars, pyroxenes, quartz, and apatite were irradiated in the Berkeley HILAC with neon and argon ions of up to 10.2 MeV/amu with maximum doses of 1.6×10^{13} argon ions/cm^2 and 4.0×10^{13} neon ions/cm^2, respectively. The samples were thinned to thicknesses near 30 microns, stacked to form the target, and then immersed completely in the ions beams. X-ray and optical observations revealed: a crystal distortion and curvature with the argon irradiation similar to that produced in mica; a lesser effect from neon bombardment; a fracturing of the crystal samples, which depended on the total dose and energy of the incident ion; polygonized structures produced when either neon or argon ions (with sufficiently high concentration) were trapped within the crystals. The interpretation of the measurements, their correlation with the mechanism of track formation, implications concerning the alteration of the lunar surface due to solar particles, and the exposure of lunar and meteoritic material to solar-flare cosmic rays are discussed. (France)

Stars

Refer also to abstract 45255.

45167 (AD-718320) PHOTOINDUCED BETA DECAY OF PROTONS AND NEUTRONS IN STELLAR INTERIORS. Hayes, John N. (Naval Research Lab., Washington, D. C.). 6 Jan 1971. 30p. (NRL-7124). NTIS.

In this first phase of a study on photon-induced beta decay, the reaction rate for $\gamma + p \rightarrow n + e^+ + \nu_e$ is determined for conditions approximating those in stellar interiors. It is shown that the lifetime of the proton in such conditions drops from infinity to only microseconds as the temperature varies from 0 to 10^{12}°K. Hence the stability of the proton against this reaction is not seriously altered and will not affect nucleosynthesis (which depends on the availability of protons). However, the reactions $\gamma + n \rightarrow p + e + \bar{\nu}_e$ and $e + p \rightarrow n + \nu_e$ are not restrained by threshold-energy requirements. If the neutron's lifetime is drastically reduced by this latter reaction to the point that it cannot live long enough to react with nuclei, then nucleosynthesis in stars will be curtailed at very high temperatures. Attempts in this latter case to proceed with calculations along the same line as the $\gamma + p$ calculation run immediately into a divergence problem, as is shown here. The correct handling of this reaction will be the subject of another report when completed. (auth) (USGRDR)

45168 THERMAL STABILITY OF THE HELIUM-BURNING SHELL IN STARS OF 15 SOLAR MASSES. Dennis, Tom Ross. Princeton, N. J.; Princeton Univ. (1970). 34p. University Microfilms Order No. 71-14,369.

Thesis.

The thermal stability of the helium-burning shell in a model for a red supergiant of 15 $M_\odot$ is discussed. On the basis of a linear stability analysis the model is shown to be thermally stable by a large margin. A semi-quantitative physical analysis reveals that the primary stabilizing factor is the presence of substantial radiation pressure in the helium-burning shell. The stability seems therefore to be related to very basic properties of the model, which would be likely to be encountered in any reasonable model for a massive star ($M/M_\odot \geq 15$) containing a helium-burning shell source. (Diss. Abstr. Int., B)

45169 MICROTURBULENCE AND ABUNDANCE ANOMALIES IN CLUSTER METALLIC-LINE A STARS. Smith, Myron Arthur. Tucson, Ariz.; Univ. of Arizona (1971). 241p. University Microfilms Order No. 71-15, 929.

Thesis.

High-dispersion spectra were obtained for sixteen metallic line (Am) stars in three galactic clusters and for four normal standards. Three spectra of each star were obtained in the blue at 8.9 A/mm dispersion, and two in the yellow at 17.8 A/mm. A detailed model-atmospheres curve of growth analysis was made of the equivalent-width data of each star in order to obtain microturbulent parameters and abundances. (TSS) (Diss. Abstr. Int., B)

45170 NEUTRON STARS: EQUATION OF STATE OF MATTER AT VERY HIGH DENSITIES. Craft, James Winslow. Los Angeles; Univ. of California (1970). 279p. University Microfilms Order No. 71-13,989.

Thesis.

The equation of state of matter at very high densities ($10^{13} < \rho < 10^{16}$ g/cc) was calculated for a number of two-nucleon interactions. It was assumed that only electrons, muons, and eleven species of baryons (the octet plus three members of the $\Delta(1236)$ quartet) are present in such matter, other particles being too massive or having decayed, annihilated, or escaped from the system. The nucleon–nucleon interaction was described by a number of phenomenological two-body potentials designed to fit various low-energy nuclear physics data, such as scattering data and nuclear matter binding properties. Among these potentials were the velocity-dependent ones of Nestor, et al., (1968), and Weiss and Cameron (1969). The Reid (1968) soft core was also investigated, in particular, attempting to extend the calculation of Nemeth and Sprung (1968). The higher-mass baryons were assumed to interact by way of the same two-body potentials used for the nucleons. Specifically, each pair of baryons was treated as two isospin-½ particles, with appropriate account made of the exclusion principle. In two-particle systems consisting of one or more spin-3/2 particles, the total spin-2 and/or -3 states were neglected. The distribution of particle densities as a function of mass density, determined by minimizing the total system mass–energy subject to the two constraints of charge neutrality and baryon number conservation, was found to differ fundamentally from that calculated by Tsuruta and Cameron (1966b). In particular, the threshold densities for the appearance of the various species were considerably lower, by factors of as much as 10. As a consequence of this fundamentally different distribution, the equations of state showed a region ($4.5 \times 10^{14} < \rho < 1.5 \times 10^{15}$ g/cc) of negative pressure, that is, the system was bound even in the absence of gravitation. Briefly, this effect is due to the fact that the percentage of neutrons at these densities is cut down from 99% (for the Tsuruta–Cameron model) to 60% or below. Therefore, the repulsion due to the neutron kinetic energy and the exclusion principle is drastically reduced, while the attraction from unlike pairs (no exclusion) of baryons is increased. The equations of stellar structure were then solved for these equations of state for various values of central density. The gravitational mass and star radius, along with the angular momentum for a slowly-rotating star, were calculated and compared for the several models. The negative pressure region was treated by assuming discontinuous density profiles in the stars. These results were compared with those obtained by using the Tsuruta–Cameron model, and it was found that the star models for the negative pressure equations of state had significantly smaller masses, radii, and moments of inertia. (Diss. Abstr. Int., B)

45171 LOW-DISPERSION LUMINOSITY CRITERIA IN A- AND F-TYPE STARS. Bolton, Charles Thomas. Ann Arbor, Mich.; Univ. of Michigan (1970). 48p. University Microfilms Order No. 71-15,101.

Thesis.

Using the technique of spectral synthesis, some of the luminosity criteria used in the low-dispersion spectral classification of A and F stars were investigated. It was found that for stars with solar abundances the ratio $\lambda4178:\lambda4481$ is at least as sensitive to microturbulence as it is to surface gravity. This implies that the microturbulent velocity is inversely correlated with surface gravity with very little scatter for A and F stars. It was found that, qualitatively, Am spectra are duplicated best by a model with log g = 4.3, abnormal abundances like those found by V'ant Veer–Menneret (1963) or Conti (1965) and the same microturbulence as stars with solar abundances. The "anomalous luminosity effect" in Am stars between the ratios $\lambda4178:\lambda4172$ and $\lambda4417:\lambda4481$ is attributed to the abundance of titanium. Some of the consequences for spectral classification from the possible variation of microturbulence and abundances at a given spectral type and luminosity class are discussed. This investigation demonstrates that, even with the present limited knowledge of the values and ranges of such parameters as microturbulence and abundances as a function of spectral type and luminosity class, spectral classification is a very powerful tool for studying stellar atmospheres. (Diss. Abstr. Int., B)

45172 CENTRAL STARS OF PLANETARY NEBULAE SHOWING O- OR OF-TYPE SPECTRA. Heap, Sara Ridgway. Los Angeles; Univ. of California (1970). 296p. University Microfilms Order No. 71-16,324.

Thesis.

An attempt was made to resolve the discrepancy between the temperatures obtained from analysis of the line spectrum of O and Of-type central stars and the Zanstra temperatures, obtained from indirect estimates of the far-uv stellar flux. This problem has two aspects: (1) to isolate the source of the discrepancy, and (2) to find the correct effective temperature. The approach to both aspects was to examine the line spectrum of seven O and Of-type central stars in order to determine their effective temperatures and to search for evidence which might suggest the source of the temperature discrepancy. (TSS) (Diss. Abstr. Int., B)

45173 LATE STAGES OF STELLAR EVOLUTION: CARBON–OXYGEN STARS AND NEUTRON STARS. Boozer, Allen Hayne. Ithaca, N. Y.; Cornell Univ. (1970). 131p. University Microfilms Order No. 71-12,120.

Thesis.

The carbon–oxygen stars considered had a composition of 50% carbon and 50% oxygen by mass. The purpose of studying these stars is to understand better the stages of stellar evolution after helium shell burning. The masses considered were 1.25, 1.35, and 1.43 solar masses. The evolution was followed from the onset of carbon burning, which was in the center for all the masses considered, until the star cooled to white dwarf or ignited oxygen. All the stars studied exhausted all but about 1% of their carbon before the calculations stopped. It was found, by stepping up the mass of the 1.35 solar mass star fairly late in its evolution, that it takes 1.37 solar masses to ignite neon (a product of carbon burning) and that the neon flash ignites the oxygen. A discussion is given of the thermal structure of stars which lose most of their heat by neutrinos. Zero-temperature models of the burned out cores of carbon–oxygen stars were also considered to find the maximum size a cold, burned-out carbon–oxygen star can have (about 1.35 $M_\odot$), to investigate the effects of general relativity, and to see how well the binding energy of shell-burning carbon–oxygen stars could be reproduced by zero temperature models. Neutron stars with central densities up to 4.63×10^{14} g/cm^3 were considered, using the 2B approximation of Nemeth and Sprung (1968). The lowest density for stable neutron stars was found to be 2.09×10^{14} g/cc with a mass of 0.074 $M_\odot$. The lowest density at which a neutron star was found more tightly bound than iron was 3.06×10^{14} g/cc with a mass of 0.136 $M_\odot$. The mass of a neutron star of central density 4.63×10^{14} was found to be 0.322 $M_\odot$. The method used for deriving neutron-star equations of state is described in considerable detail and the basic equations needed to calculate an equation of state are derived. (Diss. Abstr. Int., B)

45174 SOLIDIFICATION PRESSURE OF NUCLEAR AND NEUTRON STAR MATTER. Anderson, P. W.; Palmer, R. G. (Cavendish Lab., Cambridge, Eng.). Nature (London) Phys. Sci.; 231: No. 24, 145-6(14 Jun 1971).

It is stated that little attention appears to have been paid to the possibility of a neutron solid (a solid lattice of neutrons) or the density regime in which it might exist. Theoretical treatment would be prohibitively complicated, but the authors have adopted an empirical approach based on scaling the properties of He and other substances with a corresponding states argument. A solidification pressure for neutron matter is predicted and equations of state modifications are suggested. It is concluded that nuclear matter and neutron matter will both solidify at a pressure at least within an order of magnitude of 10^{28} atm. This represents a depth of only 1 to 2 km below the crust of a reasonably large pulsar, and solidification will definitely occur before the threshold for muon or hyperon formation. This is likely to be of considerable importance in the dynamical theories of pulsars. The modifications of the equation of state will also have some effect on the statics of neutron stars. (UK)

45175 ENVIRONMENT OF THE SECONDARY COMPONENT OF EPSILON AURIGAE. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York). Nature (London) Phys. Sci.; 231: No. 24, 148(14 Jun 1971).

The author replies to comments made by Demarque and Morris (Nature 230: 516(1971)) regarding his suggestion that the secondary component of Epsilon Aurigae may consist of a collapsar surrounded by a disk of solid particles that may be responsible for the observed eclipses in this system. The main points discussed are the mechanism for the origin of the dust disk, and effects due to the gas associated with the secondary component. The author concludes that the collapsar model for the secondary component is the least unlikely explanation for the system. (UK)

45176 FLUX COMPRESSION THEORIES. Erber, T.; Latal, H. G. (Illinois Inst. of Tech., Chicago). Rep. Prog. Phys.; 33: No. 11, 1069-1127(Nov 1970).

The simplest nontrivial theories of flux compression are worked out in complete detail. The approach is phenomenological and sufficiently general to cover both explosive and electromagnetic flux compressions. Extensions to gravitational flux compression (stellar collapse) are also discussed. The theories are based on exact solutions of the free boundary (Stefan) problem which connects the implosion dynamics with the flux losses. Parameter-independent comparisons of the solutions with experiment support the adequacy of the models. Comprehensive methods for data analysis were developed. With these it is possible to evaluate the phenomenological parameters which govern the implosions solely in terms of information derived from experimental records. In cases where liner thickening is essential the analytical flux compression theories must be supplemented by computer assisted solutions. Generalizations of the analytical data reversion methods can be applied to these numerical solutions. Comparison of the experimental records and computer simulations leads to direct determinations of the implosion parameters. (auth) (UK)

45177 NON-LTE EFFECTS FOR He I IN EARLY B-TYPE STARS. Poland, A.; Skumanich, A. (National Center for Atmospheric Research, Boulder, Colo.). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 18p-20(1971).

The contention by Hearn and Leckrone (1970) that non-LTE affects helium abundances derived for early main sequence stars is shown to be in error. Although the cores of some lines exhibit non-LTE effects, their equivalent widths, which are dominated by line wings that remain in LTE, are unaffected and yield the same helium abundances as in LTE. The lines λ6678 and λ5875 have weak wings and remain affected by non-LTE. (auth) (UK)

45178 PROPERTIES OF THE NEUTRON GAS AND APPLICATION TO NEUTRON STARS. Buchler, Jean-Robert (California Inst. of Tech., Pasadena). Contract AT(11-1)-Gen-10. Nucl. Phys.; A170: No. 1, 1-11(1971).

The binding energy of the neutron gas is calculated in Brueckner theory with Ingber's potential which is derived from meson theory. Allowance is then made for the reduction of the pressure due to protons, electrons, muons, and pions. Reservations must be made even at nuclear matter densities due to the uncertainty in the N–π^- and N–Σ^- interaction. The resulting equation of state is used to calculate the structure of neutron stars with central densities up to 10^{15} g/cm^3. (A mass of 0.62 $M_\odot$ is found at 10^{15} g/cm^3.) It is not possible, however, to determine the maximum neutron star mass, because the central density would exceed 10^{15} g/cm^3, beyond which nonrelativistic many-body calculations break down. (auth)

45179 TESNYE DVOINYE ZVEZDNYE SISTEMY S SHAROVYMI KOMPONENTAMI. (Close Binary Star Systems with Spherical Components). Shul'berg, A. M. Moscow; Izdatel'stvo Nauka (1971). 246p.

The study of close binary stars, including both eclipsing and spectral binaries, provides important information on the physical characteristics of stars and the composition of their stellar atmospheres and interiors. Masses and dimensions of the binary components and the theory of darkening at the edges of the stellar discs are examined. Methods are presented for calculating the elements of the photometric orbits of completely eclipsing spherical stars. 126 references. (tr-auth)

45180 NEUTRAL-HELIUM LINE STRENGTHS. IV. FOURTEEN NORMAL STARS OF POPULATION I. Norris, John (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 23: No. 197, 193-212(Jul 1971).

For fourteen sharp-lined stars in the spectral range BO–B8 the following observations were obtained: continuum measures over the wavelength interval 3400 to 5600 Å, profiles of the hydrogen lines Hγ and Hδ, and line-strength measurements for twelve neutral-helium lines. These data were analyzed by the use of model-atmosphere techniques and the assumption of LTE to determine the atmospheric parameters — effective temperature, surface gravity, and helium abundance. The helium line-broadening theories employed were those of Griem, Baranger, Kolb, and Oertel; Griem; and Gieske and Griem. An investigation of the derived helium abundances leads to three basic conclusions: i) For all helium lines except λλ4009, 5047, 5875, and 6678 the equivalent widths yield a unique helium abundance for the early-type stars. For λλ4009 and 5047 the discrepancy may be due to difficulties of computation and errors of measurement, respectively. While non-LTE effects are found to be important for λλ5875 and 6678, some other phenomenon (possibly errors in the broadening theory) may contribute to the discrepancies obtained for these lines. ii) Measures of $D_{10}(\lambda)$, the full line width at 10% absorption, for He I λλ4026 and 4471 yield the same helium abundances as the equivalent widths. Hence, the effects of departures from LTE, though detectable in the cores of such strong lines, do not appreciably affect the measured equivalent widths. iii) The mean helium abundance of young Population I stars in the solar neighborhood is N (He)/N (H) = 0.09 ± 0.015. (The error includes the effect of possible systematic errors in the hydrogen line-broadening theory and the photometric calibration employed.) A comparison with other helium-abundance determinations for young Population I objects indicates that all measures are basically in accord with a helium abundance N (He)/N (H) = 0.09 to 0.10. (auth)

45181 NEUTRAL-HELIUM LINE STRENGTHS. V. THE WEAK-HELIUM-LINE STARS OF POPULATION I. Norris, John (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 23: No. 197, 213-33(Jul 1971).

Effective temperatures, gravities, and apparent helium deficiencies were determined for twelve weak-helium-line stars. Compared with normal Population I stars these stars are apparently helium deficient by factors of 2 to 15. The stars studied do not form a homogeneous group with regard to the line strengths of other elements. Three stars — 3 Sco, HD 144334, and 162374 —

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appear to be related to the Si λ4200 stars, having Si II line strengths intermediate between normal and those found in the Si λ4200 stars. Lines of phosphorus are present in four of the samples: ι Ori B, 3 Cen A, HD 144661 (probable), and 144844. The weak-helium-line stars occupy a restricted range in effective temperature ($0.25 \leq \theta_e \leq 0.35$) and define a boundary in the (θ_e, log g)-plane stretching from $\theta_e = 0.25$, log g = 4.4 to $\theta_e = 0.35$, log g = 3.5. It is suggested that the position of these stars in this plane is consistent with the hypothesis presented by Michaud that the helium weakness in the peculiar stars is due to the preferential diffusion of neutral helium. (auth)

45182 NEUTRAL-HELIUM LINE STRENGTHS. VI. THE VARIATIONS OF THE HELIUM SPECTRUM VARIABLE α CENTAURI. Norris, John (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 23: No. 197, 235-55(Jul 1971).

Spectra (λλ3800 to 6700) and continuum measures (λλ3400 to 5600) were obtained of α Cen during the years 1967–1969. These were used to determine the variations of several observational parameters: hydrogen line profiles, helium and metallic line strengths, continuum magnitudes and colors, and radial velocities. The period of the helium-line variations was found to be 8.814 days — in disagreement with the period of 8.8172 days obtained from spectral-type data stretching back to 1895. This suggests that the variation is not strictly periodic. An analysis of the hydrogen line profiles, the continuum measures, and the helium line strengths showed that while the helium abundance apparently changes from ϵ(He) [= N(He)/N(H)] = 0.004 to 0.23, only small changes in effective temperature and gravity are allowed. While the helium line strengths show no evidence for departures from LTE, and may be explained in terms of an uneven element distribution over the surface of a rotating star ("rotator" hypothesis), the metallic-line variations defy explanation in terms of such a model. In particular, the lines of Si II show no variation, while those of Si III show an antiphase variation with respect to the helium lines. All of the metallic lines either show no variation or vary in antiphase with those of helium. The radial-velocity measures, however, exhibit the same behavior for both the helium and the metallic lines. This leads to the rejection of the "rotator" hypothesis. It is suggested that α Cen may be related to the peculiar A and B stars. This is made feasible by the existence of a probable helium spectrum variable, HD 162374, among the weak-helium-line stars, and the position of α Cen in the (θ_e, log g)-plane where it coincides with the region found to be occupied by the weak-helium-line stars. (auth)

45183 EVOLUTION OF STARS CONTAINING ^{3}He. Ulrich, Roger K. (Univ. of California, Los Angeles). Astrophys. J.; 168: No. 1, 57-70(15 Aug 1971).

Iben and Talbot have shown that the determination of stellar ages in NGC 2264 from gravitational-contraction times alone leads to the conclusion that many low-mass stars are up to 5 times older than the oldest stars of higher mass. Calculations show that ^{3}He burning halts gravitational contraction along an evanescent main sequence roughly 2 mag above the normal main sequence. It is suggested that the apparent youth of the high-mass stars is due to ^{3}He burning. An estimate of the age of NGC 2264 and the stars near the Orion Nebula from evolution of the upper main sequence and the gravitational ages of low-mass stars then yields an initial ^{3}He abundance which is much larger than the ^{3}He abundance in gas-rich meteorites. Envelopes of low-mass stars are a likely site for the formation of the ^{3}He. (auth)

45184 EQUILIBRIUM AND PULSATIONAL PROPERTIES OF THE LOWER HELIUM MAIN SEQUENCE. Hansen, Carl J.; Spangenberg, William H. (Univ. of Colorado, Boulder). Astrophys. J.; 168: No. 1, 71-8(15 Aug 1971).

Results are presented for pure-helium models in complete equilibrium within the mass range $0.3 \leq M/M_\odot \leq 1.35$. The models are double valued with respect to mass whereas the central density ρ_c is monotonic. Nuclear-driven pulsational instability was found for models with $\rho_c \gtrsim 2 \times 10^5$ g cm^{-3} ($M/M_\odot \gtrsim 0.33$) and having periods less than ~40 sec. Hydrogen-rich envelopes are added to some models for realism, which further reduces maximum periods (for instability) to 20 sec or less. Some discussion is included to argue against the higher-density models representing reasonable stellar objects. (auth)

45185 PHOTOIONIZATION CROSS-SECTIONS FOR ATOMS AND IONS OF SULFUR. Chapman, Robert D. (Goddard Space Flight Center, Greenbelt, Md; Henry, Ronald J. W. Astrophys. J.; 168: No. 1, 169-71(15 Aug 1971).

Photoionization cross-sections were calculated for all levels belonging to the configuration $1s^2 2s^2 2p^6 3s^2 3p^3$ of atoms and ions of sulfur. Hartree–Fock functions were used to describe the bound atomic states which are required in the matrix elements for the cross-sections, and the close-coupling approximation was used to obtain continuum wave functions. The results were fitted to an interpolation formula which gives the cross-sections as a function of wavelength from threshold to ~100 Å. No extensive calculations have been made previously for these systems. (auth)

45186 METHOD FOR SUPPRESSION OF THE THERMAL INSTABILITY IN HELIUM-SHELL-BURNING STARS. Sweigart, Allen V. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 168: No. 1, 79-97(15 Aug 1971).

Two methods for suppressing the thermal instability of the helium-burning shell in a 1 $M_\odot$ Population II star were investigated. The use of large time steps as a possible method of flash suppression for this type of star fails because of large structural changes between models. A second method based on omitting the release of gravitational energy gives results in close agreement with the mean evolution expected from available calculations covering the initial fifteen relaxation cycles. These results are shown to be insensitive to changes in the composition distribution resembling those produced by the flash convection. This method might thus furnish an efficient means for studying the second red-giant phase without the need for extensive calculations of relaxation cycles, an otherwise nearly prohibitive task. A stability analysis indicates that the thermal instability leads to true relaxation oscillations and that shell sources containing little mass can be strongly stabilized by perturbations in the composition. Seven advanced relaxation cycles were computed by reinserting the release of gravitational energy into the flash-suppressed models. Except for an enhancement of the helium-burning rate at the main flash peak and for a considerable reduction in the cycle length, the advanced cycles are basically similar to earlier cycles in regard to both the total amount of helium burned per cycle and the maximum extent of the flash convection. (auth)

45187 COMPUTED AND OBSERVED CYANIDE-RADICAL SPECTRA OF THREE N STARS IN THE INFRARED. Fay, Theodore D. Jr. (Indiana Univ., Bloomington). Astrophys. J.; 168: No. 1, 99-107(15 Aug 1971).

Synthetic spectra of the cyanide radical, CN, were computed for the (1,0) and (0,2) band sequences at wavelengths near 1.0 and 2.3 μ, by means of a Milne–Eddington model. Morris and Wyller's elemental abundances for N stars were used, with the negative hydrogen ion assumed as the principal opacity source besides CN. Vibrational and rotational temperatures of 3000°K were used, and five values of the $^{12}C/^{13}C$ ratio (1, 2, 5, 20, and 1000) were considered. These spectra were then broadened with a running Gaussian profile to simulate the instrumental profiles of observed infrared spectra of RY Dra, Y CVn, and 19 Psc. The $^{12}C/^{13}C$ ratios that give the best agreement with infrared observations ranges from 2 to 5 for RY Dra and Y CVn, but the ratio is greater than 20 for 19 Psc. (auth)

45188 OLD DISK METAL-RICH SUBGIANT 31 AQUILAE. Hearnshaw, J. B. (Australian National Univ., Canberra). Astrophys. J.; 168: No. 1, 109-14(15 Aug 1971).

A differential coarse curve-of-growth analysis was carried out with respect to the Sun for the high-velocity field subgiant 31 Aql. The results show most metals to be 4 times as abundant as in the Sun. The age of 31 Aql is probably similar to that of NGC 188, the oldest open cluster known. The results for 31 Aql are contrary to the hypothesis that the oldest stars in the Galaxy should be metal poor. (auth)

45189 EXPANSION OF THE OPTICAL REMNANT OF B CASSIOPEIAE = 3C 10. van den Bergh, Sidney (Univ. of Toronto, Richmond Hill, Ont.). Astrophys. J.; 168: No. 1, 37-9(15 Aug 1971).

Intercomparison of four 200-inch plates taken between 1949 and 1970 shows that the filamentary shell of Tycho's supernova has suffered considerable deceleration. The presently observed expansion rate is consistent with a Sedov similarity solution. This result suggests that the expanding shell of Tycho's supernova has swept up a mass of interstellar gas that is several times greater than its own mass. Individual filaments exhibit significant changes on a time scale of 10 years. (auth)

45190 STARS AND THE STRUCTURE OF THE GALAXY. Woolley, Richard. Quart. J. Roy. Astron. Soc.; 11: No. 5, 403-28(Dec 1970).

This lecture discusses work accomplished during the last 150 years on the subject of stellar dynamics and structure of the Milky Way. (W.D.M.)

45191 REBUTTAL OF COMMENTS BY BANDYOPADHYAY AND RAY CHAUDHURI ON THE PAPER ASTROPHYSICAL EXCLUSION OF PHOTON–NEUTRINO WEAK COUPLING. Stothers,

R. B. (Goddard Inst. for Space Studies, New York). Phys. Lett.; 36A: No. 1, 5-7(2 Aug 1971).

The astrophysical arguments presented by Bandyopadhyay and Ray Chaudhuri against the author's negative result of a test of Bandyopadhyay's theory of photon–neutrino coupling are shown to be incorrect or irrelevant. The evidence adduced by them as supposedly favoring the theory is actually evidence against it, when properly examined. (auth)

45192 STAR FORMATION. Penston, M. V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Contemp. Phys.; 12: No. 4, 379-94(Jul 1971).

A brief review of the interstellar medium and its instabilities is given with particular emphasis to recent results on its "two-phase" nature. The existing models (both numerical and analytic) of the collapse of gas clouds to form stars are discussed; this discussion is divided into the optically thin and thick phases. Some aspects of the observations of young stars are considered. (auth) (UK)

45193 CONCENTRATION CLASSES OF GLOBULAR CLUSTERS. Kukarkin, B. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 89-93(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 113-19(Jan-Feb 1971).

The Shapley–Sawyer "concentration classes" of globular clusters are discussed. The classes are shown to correlate only very weakly with the true star concentration in globular clusters. A revision of these classes was accomplished through inspection of many plates and prints. All previous classifications and this determination are reduced to a uniform system of new indices. There is a well-defined relation between these indices and the integrated absolute magnitudes of the globular clusters. The new index is called the "index of richness" (IR). The absolute magnitudes M_B and M_V of globular clusters are related to IR by the linear equations $M_B = -4.80 - 4.71 \cdot IR$, $M_V = -5.55 - 4.78 \cdot IR$. These equations may be applied for estimating the apparent distance modulus m–M if the integrated apparent magnitudes of a cluster in the B and V systems are known. (auth)

45194 QUANTITATIVE ESTIMATE FOR THE BRIGHTNESS ANISOTROPY OF B STARS. Arshinova, V. A.; Radzievskii, V. V. Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 94-8(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 120-5(Jan-Feb 1971).

In order to obtain an undistorted value for the brightness anisotropy of B stars, a method was applied based on a normal velocity distribution for the stars, with equal numbers of stars having positive and negative radial velocities V_r. The faintest stars having $V_r > 0$ were excluded. A statistical analysis of 1044 B stars using this method enabled the brightness difference Δm to be evaluated in three different ways and the probable error of the result to be estimated. For stars of subtypes B0-B4 with negative and positive radial velocities the brightness difference was found to be $\Delta m = 0.80 \pm 0.14$m for stars throughout the celestial sphere, $\Delta m = 0.78 \pm 0.10$m for stars in a 20° zone centered on the galactic equator, and $\Delta m = 1.03 \pm 0.13$m for stars in a 20° zone about the equator of the local system. This result suggests that dust material is preferentially concentrated in the vicinity of "Gould's belt." The K effect was interpreted as arising from the screening of the stars by dust in the apex direction of their motion. (auth)

45195 CEPHEID S Vul AND THE ASSOCIATION Vul OB2. Tsarevskii, G. S. (Radio Astrophysical Observatory, Riga). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 169-70(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 217-19(Jan-Feb 1971).

It is shown that S Vul, the longest-period Cepheid known in the Galaxy, is a possible member of the association Vul OB2. The boundaries of the association are improved, new members are proposed, and a distance modulus $V_0 - M_V = 13.12 \pm 0.17$m is determined (r = 4000 ± 300 pc). The values of the radial velocity and color excess imply that S Vul is a member of the association. In this event M_V(S Vul) = –6.4m is in excellent agreement with Sandage and Tammann's period–luminosity relation. (auth)

45196 COLLAPSED STARS IN BINARY SYSTEMS. Guseinov, O. Kh.; Novruzova, Kh. I. (Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 173-4(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 221-3(Jan-Feb 1971).

The possibility that a binary system may be disrupted when one of its components collapses is discussed. It is found that a neutron star must be located at least 5×10^{12} cm from the primary and a collapsed star at least 5×10^{11} cm if the system is to persist. (auth)

45197 NEW DOUBLE STAR SURVEY: ITS MOTIVATION. Couteau, P. (Observatoire, Nice). Astron. Astrophys.; 13: No. 3, 345-7(Aug 1971). (In French).

Preliminary results of the survey at the Nice Observatory are given. A relation is set up giving, as a function of the observed elements, the probable period of a binary, at the time of discovery. This relation is verified with the observed periods, then is used for the calculation of the probable period and parallax of the newly discovered binaries. (auth)

45198 X-RAY EMISSION OF FLARE STARS. Gurzadyan, G. A. (Byrakan Astrophysical Observatory, Erevan). Astron. Astrophys.; 13: No. 3, 348-52(Aug 1971).

The possibility of generating x-ray emission during stellar flares is analyzed within the framework of the hypothesis of "fast electrons". It is shown that the nonthermal bremsstrahlung of fast electrons may be the basic mechanism for generating x-ray photons in flare stars. The expected x-ray fluxes are fairly high: from 2 to 3 up to 300 photons/cm^{2}s in the case of UV Cet, and from 0.1 to 10 photons/cm^{2}s in the case of AD Leo, in the wavelength region shortward of 10 Å. The duration of x-ray flares will be substantially less than the duration of optical flares. The theoretical spectrum of the x-ray emission is derived. It has a maximum at 0.05 Å, does not depend on the physical parameters of the star, and is the same in all flares. The same fast electrons with an energy of the order of 1.5×10^6 eV can account for the generation of flares over a wide frequency—from x rays to radio waves. However, the mechanism for inducing flares varies from one range to another: x-ray flares are caused by nonthermal bremsstrahlung, optical flares by the inverse Compton effect, and radio emission by a synchrotron mechanism. (auth)

45199 EFFECT OF RAPID ROTATION ON RADIATION FROM STARS. III. STRONG HELIUM I LINES. Hardorp, Johannes (State Univ. of New York, Stony Brook); Scholz, M. Astron. Astrophys.; 13: No. 3, 353-8(Aug 1971).

For main-sequence models of rapidly rotating stars of 3.55 to 8.1$M_\odot$, line profiles of He I λ4471 and λ4026 were computed in the LTE approach, replacing the earlier computations of He I λ5875. The conclusions of paper II were not changed by the new results—in particular, the broadest-lined stars can be understood as rotating near maximum speed. The new computations may aid detection of rapid rotators viewed under intermediate angles. The consequences of an error in the paper by Roxburgh et al. (1965) on the results of papers I, II and III are briefly discussed. (auth)

45200 PRODUCTION OF WHITE DWARFS IN BINARY SYSTEMS OF SMALL MASS. Refsdal, S.; Weigert, A. (Hamburger Sternwarte, Hamburg. Univ. of Oslo). Astron. Astrophys.; 13: No. 3, 367-73(Aug 1971).

For most binary systems of small mass, which end up with a He white dwarf, the evolution through mass transfer is very simple. While the initial system depends on three parameters, the final white-dwarf system depends only on two parameters (total mass and total orbital angular momentum). Therefore, simple formulae can be derived that predict the properties of the final system, e.g., final masses or orbital velocities. These formulae are discussed, for instance, in view of applications to blue stragglers. (auth)

45201 GLOBULAR CLUSTER NGC 6541. Alcaino, G. (Univ. Catolica de Chile, Santiago). Astron. Astrophys.; 13: No. 3, 399-404(Aug 1971).

A UBV photometric investigation of the globular cluster NGC 6541 was carried out at the European Southern Observatory using the 1-meter reflector for the photoelectric work and at the Cerro Tololo Inter-American Observatory using the 1.5-meter reflector for the photographic work. Fifteen stars were observed photoelectrically to apparent magnitude V = 15.67. With this sequence, 283 stars were calibrated photographically. The apparent distance modulus is (m – M) app = 14.50. The reddening is E(B – V) = 0.18. The true distance modulus is $(m - M)_0 = 13.96$. The distance is 6195 pc from the Sun and 1182 pc from the galactic plane. The giant branch rises 2.8 magnitudes above the horizontal branch at $(B - V)_0 = 1.4$, characteristic of a metal poor object. A 3.85 magnitude change in brightness was detected in a probable member, from two blue plates obtained 647 days apart. The star is suspected to be a "short-long period variable" of Population II. (auth)

45202 STAR S22 OF THE LARGE MAGELLANIC CLOUD SHOWING EMISSION LINES OF Fe II AND [Fe II]. Fehrenbach, Ch. (Observatoire, Marseille). Astron. Astrophys.; 13: No. 3, 437-43(Aug 1971). (In French).

The results of a preceding article (Fehrenbach, Maurice, Prévot, 1969) were confirmed. The emission lines of the following elements were again found: H, Fe II, and [Fe II] but the two lines of the multiplet 1 F of [S II] that are certain were added. The 4076 line had not been found so a doubt remained, but now the two lines are present. Identification of [Ni II] was confirmed; plus the following elements: Cr II, Si II, Ti II with weak or rather weak lines. It was thought that [Fe III] might also be present (line 4658). He I lines

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were found but certain weak lines that can be identified as He II lines were difficult to understand. (auth)

45203 OBSERVATIONAL EVIDENCE OF NON-LTE EFFECTS FOR O-TYPE STARS. Maeder, A. (Observatoire, Geneva). Astron. Astrophys.; 13: No. 3, 444-6(Aug 1971).

An uv excess of 0.01 to 0.02m exists for Of, O9 I, and O9.5 I stars in comparison with absorption-line O stars of the same spectral type. According to the references given, the Of stars have a higher luminosity relative to absorption-line O stars of the same spectral type. If so, the observed effect for Of, O9 I, and O9.5 I stars is in strong disagreement with LTE models for O-type stars. On the other hand, the agreement with non-LTE models by Auer and Mihalas (1971) is excellent. (auth)

45204 NEW WAVELENGTHS' TABLE FOR DETERMINATION OF RADIAL VELOCITIES OF LATE-TYPE STARS. Cheriguene, M. F. (Observatoire, Marseille). Astron. Astrophys.; 13: No. 3, 447-53(Aug 1971). (In French).

A new system of stellar lines in the spectral region 4800 to 5500 Å was established which permits one to obtain the radial velocities of late-type stars (F6–M2). Radial velocities of 23 standard stars, 7 stars in the Hyades cluster, and 13 stars in Coma Berenice are given. (auth)

45205 PROFILES OF THE [O III], 5007 A LINE FROM THE DUMB-BELL NEBULA. Meaburn, J. (Univ. of Manchester, Eng.). Astron. Astrophys.; 13: No. 3, 478-86(Aug 1971).

The profiles of the [O III] line were observed at 23 positions across the Dumb-bell Nebula (NGC 6853) with a two-etalon scanning Fabry–Perot. It is shown that the [O III] region is not simply an expanding shell. Very-involved nebular motions are indicated. The application of the Jones and Misell (1970) method of deconvolution to this type of observation is examined in some detail. (auth)

45206 DOUBLE-VALUED NATURE OF THE HYDROGEN MAIN SEQUENCE. Grossman, A. S.; Opoien, J. W. (Iowa State Univ., Ames). Astron. Astrophys.; 13: No. 3, 487-8(Aug 1971).

A calculation was made for a 0.1-$M_\odot$ star at the composition X = 0.68, Y = 0.29, and an l/H_p value of 1 which showed that there are two possible, stable, hydrogen main-sequence configurations for the above parameters. (auth)

45207 NEW PLANETARY NEBULAE. Kohoutek, L. (Hamburg Observatory). Astron. Astrophys.; 13: No. 3, 493-5(Aug 1971).

New planetary nebulae of low surface brightness were discovered on the Palomar Sky Atlas, especially in the declination zones −36 and −42°. The co-ordinates, short description, and identification charts of the individual objects are given. (auth)

45208 NUCLEOSYNTHESIS OF REMOTE TRANSURANIUM ELEMENTS. Chechetkin, V. M. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 45-50 (Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 59-65(Jan-Feb 1971).

The formation of transuranium elements at high temperatures and high densities is discussed. The possibility of producing transuranium elements through the external r process under conditions of partial thermodynamic equilibrium is demonstrated. (auth)

45209 DENSITY INVERSION IN THE CONVECTIVE ENVELOPES OF STARS. Ergma, E. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 51-3(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 66-9(Jan-Feb 1971).

The appearance of a density inversion in stellar envelopes with $T_{eff} \leq 10^{4.6}$°K was investigated. It is shown that the structure of the convection zone for stars with $M > 10\,\mathfrak{M}_\odot$ is insensitive to a change in α in the equation $l = \alpha Hp$; there is always a density inversion in such stars. For stars with $M \leq 4\,\mathfrak{M}_\odot$ the structure of the convection zone is sensitive to a change in α and one can always find a value of α for which a density inversion does not exist. (auth)

45210 INTERPRETATION OF TYPE I SUPERNOVA SPECTRA. Mustel, E. R. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 1-8(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 3-13(Jan-Feb 1971).

Line identifications are presented which rest on the following empirical facts: (a) near maximum light the temperature of Type I supernovae is ≈6000°K; (b) the radiant intensity immediately beyond λ ≈ 3600 Å is anomalously low; and (c) there are reasons to believe that the mean expansion velocity of Type I supernova envelopes is V ≈ 10,000 km/sec. The spectra of the Sun (Type dG2) and of DQ Her at maximum light (cF5) are taken to represent the lower and upper limits for the level of excitation and ionization of the atoms at T ≈ 6000°K. Figures, plotted for $\varkappa = \Delta\lambda/\lambda = -0.03$ (V ≈ 9000 km/sec), demonstrate that the shifted spectrum of DQ Her provides a quite satisfactory explanation of the chief properties of Type I supernova spectra. In particular, the maxima δ, ζ, and η (especially δ) are comparatively free of absorption lines and are quite strong. However, some of the properties, such as the high intensity of the Na I $D_{1,2}$ and λ 4227 Ca I absorption lines, reflect the comparatively low level of excitation and ionization for the atoms in the envelopes, that is, an appreciable contribution from a solar-type spectrum in supernova spectra. This circumstance apparently results from the presence of a substantial temperature gradient in the envelopes. The large width of the lines in Type I supernova spectra arises from the following factors: a) the large mass of supernova envelopes; b) the anomalously low electron concentration n_e, due to the reduced emission beyond λ ≈ 3600 Å, at least in the range of the ionization energy of such atoms as Na I and Ca I. The diminished value of n_e causes a drop in the absorption coefficient $\varkappa_\nu$ as well as a considerable rise in the ratio $\eta_\nu = \sigma_\nu/\varkappa_\nu$. The occurrence of abnormal supernovae appears to be related to anomalously low values for the expansion velocity V of the envelopes of the stars. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 45478.

45211 (AD-719864) MEASUREMENT OF GAMMA-RAY SPECTRA OF CELESTIAL LARGE-ENERGY SOURCES. Final Scientific Report, February 1, 1969–October 31, 1970. Haymes, R. C. (Rice Univ., Houston, Tex. Dept. of Space Science). 31 Jan 1971. Contract F44620-69-C-0083. 7p. (AFOSR-TR-71-548). NTIS.

In order to provide clues as to the mechanisms by which some celestial sources generate hugh amounts of energy, a series of balloon-altitude experiments were undertaken during 1969 and 1970. They measured gamma spectra in the energy range 25 to 975 keV from discrete celestial sources including the Crab Nebula, pulsars NP 0532 and PSR-0835-45, the center of the Galaxy, radio galaxies Virgo A and Centaurus A, as well as from the galactic sources Cyg XR-1, Sco XR-1, and Cen XR-4. Significant new information on these objects and their energy sources was obtained and is discussed. (auth) (USGRDR)

45212 PHOTOIONIZATION OF GAS CLOUDS BY NON-THERMAL RADIATION SPECTRA. Davidson, Kris David Ithaca, N. Y.; Cornell Univ. (1970). 218p. University Microfilms Order No. 71-12,126.

Thesis.

In an effort to account for the major emission-line intensities in the spectra of certain astronomical objects such as quasi-stellar objects and the Crab Nebula, a program was developed for calculating the ionization equilibrium in a gas cloud excited by a source of ionizing photons, which may extend to x-ray frequencies. (TSS) (Diss. Abstr. Int., B)

45213 ENERGY LOSS OF ROTATION AND RADIOFREQUENCY RADIATION OF PULSARS. Vitkevich, V. V.; Suleimanova, S. A. (Moscow Inst. of Physics). Kratk. Soobshch. Fiz.; No. 12, 42-7(Dec 1970). (In Russian).

For typical pulsars the energy loss due to rotational deceleration amounts to 10^{31} to 10^{33} erg/sec. For radiofrequency radiation the energy loss may be three orders of magnitude less. Correlation of loss of kinetic energy (−dW/dt) due to pulsar rotation and the radiofrequency luminosity (S) was considered. Upon analyzing the characteristics of twelve slow pulsars an acceptable correlation between S and dW/dt was observed. For the eight in best agreement, the ratio of S to dW/dt was 6×10^{-4}; it was concluded that these eight pulsars form an extremely uniform system. (K.S.W.)

45214 PULSAR GLITCHES. Boerner, G. (City Coll., New York); Cohen, J. M. Nature (London) Phys. Sci.; 231: No. 24, 146-7(14 Jun 1971).

The term glitch is used to denote a sudden increase in rotational frequency, observed for two pulsars, after which the usual slowing down was resumed. NP 0532 showed such an increase on Sept. 28, 1969, associated with an increase of activity in the nebula. There have been several attempts to account for this, and the present authors suggest that the glitch might have been caused by a massive body falling on the pulsar and transferring angular momentum to it. It is noted that PSR 0833-45 also showed a glitch between Feb. 24 and March 3, 1969, that could also be attributed to the infall of mass. The energy set free in these processes, giving rise to activity in the system, is also discussed. (UK)

45215 THEORY AND ANALYSIS OF INTERPLANETARY SCINTILLATIONS. Lovelace, Richard V. E. Ithaca, N. Y.;

Cornell Univ. (1970). 420p. University Microfilms Order No. 71-14,651.

Thesis.

Several problems of the theory of interplanetary scintillations and the analysis of observations were investigated. The propagation of a wave deep into a medium having random spatial variations of index of refraction is discussed with geometrical optics and a wave optics model. It is shown with geometrical optics that nearby rays typically spread apart exponentially with propagation distance. Consideration of the wave propagation takes into account the exponential spreading of rays. The wave-optics model consists of an arbitrary number of thin parallel phase-changing screens, and it permits exact evaluation of certain correlation functions. The two approaches are compatible, and both indicate that a deep medium is equivalent in several respects, but not all, to a thin phase-changing screen. Observations of weak interplanetary scintillations are described that indicate a power-law wavenumber spectrum of electron-density irregularities. The theory of scattering and scintillations for power law spectra is worked out. In contrast with cases where there is only a single dominant irregularity size, two new effects occur: first, the position of a radio source may vary randomly with time simultaneous with angular broadening and weak or strong scintillations. Secondly, a sequence of narrow equispaced pulses received through a medium with a power law spectrum may show a random variation in arrival time. The power law theory is compared with observations of interplanetary scattering and weak and strong scintillations. There is good quantitative agreement on all the points examined. A theory connecting density and magnetic field fluctuations is proposed for the interplanetary medium. The theory is compatible with magnetic field observations by the Mariner 2 space probe, and it implies some properties of the density fluctuations deduced from interplanetary scintillations. The theory suggests a close connection between the processes causing small-scale (~50 km) density fluctuations observed in interplanetary scintillations and the large-scale ($>10^4$ km) magnetic field variations detected by Mariner 2. A theory of interplanetary–interstellar scintillations is developed and applied to preliminary observations of the intensity variations of the pulsar CP 0950. The limited comparison of theory with observations shows good agreement. (Diss. Abstr. Int., B)

45216 THREE NEW VARIABLE RADIO SOURCES. Brandie, G. W.; Stull, M. A. (Univ. of Michigan, Ann Arbor). Nature (London) Phys. Sci.; 231: No. 24, 149-50(14 Jun 1971).

Variations of flux density were found for the sources DW 0723–00, OJ 287, and P 1536 + 027 at 8,000 MHz using the Michigan 85-ft radiotelescope and a wide-band radiometer with tunnel-diode amplifiers, and the observations are shown graphically. It is noted that as OJ 287 is also an optical variable it should be a good candidate for the study of possible relations between radio and optical activity. (UK)

45217 GAMMA RAYS (250 keV TO 2.3 MeV) FROM NP 0532. Orwig, L. E.; Chupp, E. L.; Forrest, D. J. (Univ. of New Hampshire, Durham). Nature (London) Phys. Sci.; 231: No. 25, 171-2 (21 Jun 1971).

Preliminary results are reported of a search for a pulsating γ-ray flux from the pulsar NP 0532 over the above energy range. A considerably lower pulsed power than previously reported was indicated, consistent with an extrapolation of pulsed spectra measured below 200 keV. The observations were made with a large NaI scintillation spectrometer, surrounded by plastic scintillator to form a shield against charged particles, and the experiment was designed to provide pulse-height analysis over the photon energy loss region from 250 keV to ~8 MeV. The experiment was carried on a balloon flight from Palestine, Texas on June 7, 1970. Results for the energy band 250 keV to 2.3 MeV are shown graphically. The average pulsed flux was calculated to be $1.44 \pm 0.57 \times 10^{-3}$ photons/cm^2/s, and the average pulsed power $6.49 \pm 2.57 \times 10^{-4}$ keV/cm^2/s/keV. Reasons are given why the use of this nondirectional instrument gives confidence that NP 0532 is emitting γ rays at the calculated average pulsed power. The results are not inconsistent with an extrapolation of the pulsed Crab measurements from x-ray energies with no change in spectral index. (UK)

45218 RADIO IDENTIFICATION OF GX 5-1. Ilovaisky, S. A.; Ryter, C. (Inst. d'Astrophysique, Paris. CEN, Gif-sur-Yvette, France). Nature (London) Phys. Sci.; 231: No. 25, 173(21 Jun 1971).

It has been suggested that the galactic nonthermal radio source A.4 should be identified with the x-ray source GX 5–1, but it is shown that such identification appears to conflict with present ideas on x-ray emission from nonthermal galactic radio sources (supernova remnants) and that the positional coincidence of these sources is fortuitous. It is recommended that the identification be dropped. (UK)

45219 RADIOSTRUCTURE OF QUASARS: STATISTICAL INVESTIGATION. Miley, George K. (National Radio Astronomy Observatory, Greenbank, W. Va.). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 477-90(1971).

Recent measurements on the angular structure of quasars have more than doubled the available data. Information on the angular structures of 127 quasars is tabulated and discussed from a mainly statistical viewpoint. The angular diameter–redshift relation was confirmed and an apparent anisotropy in the angular size distributions is discussed. (auth) (UK)

45220 COCOON PULSAR MODEL FOR SCORPIUS X-1. Davidson, K. (Princeton Univ., N. J.); Pacini, F.; Salpeter, E. E. Astrophys. J.; 168: No. 1, 45-55(15 Aug 1971).

A model is proposed for the thermal x-ray emission from Sco X-1 in terms of a hot gaseous region surrounding a rotating neutron star. This gaseous cocoon is heated by the emissions from the pulsar and, in this model, is kept at distances far outside the speed-of-light circle by a Poynting–Robertson effect. Scorpius X-1 would require a pulsar of unusually weak surface field-strength, $B_* \sim 10^{10}$ gauss, with an age of a few million years. No observable periodic intensity variations with the pulsar period (~5 msec) are predicted. (auth)

45221 DETECTION OF RADIO RECOMBINATION-LINE EMISSION ASSOCIATED WITH DISTRIBUTED IONIZED HYDROGEN. Jackson, P. D.; Kerr, F. J. (Univ. of Maryland, College Park). Astrophys. J.; 168: No. 1, 29-35(15 Aug 1971).

H109α–H110α line emission was detected (at $l = 31\overset{\circ}{.}2$, $b = 0\overset{\circ}{.}0$) which is believed to be associated with a distributed component of the galactic ionized gas. This association is based on a comparison of the velocity profile of the line with the corresponding 21-cm-line profile of neutral hydrogen at the same position, and on an estimate of the electron temperature of the emitting gas. (auth)

45222 REDDENING OF CASSIOPEIA A. Searle, Leonard (Hale Observatories, Pasadena, Calif. Carnegie Institution of Washington, D. C.). Astrophys. J.; 168: No. 1, 41-3(15 Aug 1971).

Photoelectric measurements of emission-line strengths from a condensation in the nebulosity associated with the radio source Cas A are reported, and the interstellar reddening is found from the ratio of the auroral to the transauroral lines of [S II]. (auth)

45223 TWO BRIGHT NEW QUASI-STELLAR RADIO SOURCES. Browne, I. W. A. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 231: No. 5304, 515-16(25 Jun 1971).

In a 2695-MHz survey of radio sources made with the Jodrell Bank Mark II radio telescope two very bright (14.5 magnitude) objects, separated by less than 2° in the sky, were observed, and it was considered that these might be worthy of further attention. These objects were designated B2 1215 + 30 and ON 231. The available spectral information for these two sources is given in tabular form, and from the limited data it appears reasonably certain that ON 231 has an inverted spectrum, whereas that of B2 1215 + 30 is relatively flat. ON 231 is completely stellar on both the red and blue sky survey prints, but there is an 18-magnitude galaxy-like object that might be described as a "jet" lying 12 arcs from the main star. Conclusions as to the true nature of ON 231 and B2 1215 + 30 must await studies of their optical spectra and the variability of their optical and radio emission. If ON 231 is a quasar and the object in close proximity is a field galaxy, then neutral hydrogen absorption due to the galaxy should be detectable in the radio spectrum of the source, provided it is located beyond the galaxy. If this absorption were detected it would lend support to the cosmological interpretation of quasar red shifts. (UK)

45224 ROTATION MEASURE AND INTRINSIC ANGLE OF THE CRAB PULSAR RADIO EMISSION. Manchester, R. N. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London) Phys. Sci.; 231: No. 26, 189-91(28 Jun 1971).

Measurement of the intrinsic angle of the radio radiation is stated to provide an important test for theories of the emission mechanism. The bearing of such a measurement on the configuration of the Crab pulsar is discussed. (auth) (UK)

45225 ROTATION AXIS AND MAGNETIC FIELD AXIS OF THE CRAB NEBULA PULSAR PSR 0532 + 22. Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London) Phys. Sci.; 231: No. 26, 191-3(28 Jun 1971).

It is found that the pulse shape and the polarization data for the pulsar PSR 0532 + 22, at optical and radio wavelengths, together show that the magnetic axis is inclined at an angle of approximately 45° to the rotation axis. (auth) (UK)

45226 RAPID VARIATIONS IN HIGH-ENERGY X-RAY FLUX FROM CYG X-1. Agrawal, P. C.; Gokhale, G. S.; Iyengar, V. S. (and others) (Tata Inst. of Fundamental Research, Bombay). Nature (London); 232: No. 5305, 38-40(2 Jul 1971).

XUM

The x-ray intensity in the energy range 22.5 to 154 keV from Cyg X-1 was monitored during the night of April 5, 1971 using a balloon-borne telescope flown from Hyderabad. Pronounced variations in the intensity and presumably energy spectrum of the sources at time periods of a few minutes were observed. The detector comprised a NaI(Tl) crystal, and the results are shown graphically, together with some data for Cyg X-2 and X-3. (UK)

45227 IONIZATION STRUCTURE OF A NEBULA PHOTOIONIZED BY A FLAT SPECTRUM. Bahcall, John N. (California Inst. of Tech., Pasadena. Tel-Aviv Univ., Ramat-Aviv, Israel); Bahcall, Neta A.; Kozlovsky, Ben-Zion. Contract AT (11-1)-68. Astron. Astrophys.; 13: No. 1, 1-6(Jun 1971).

Analytic approximations were developed for the ionization structure of a medium that is photoionized by a flat spectrum. The presence of a diffuse ionization zone depends on the precise form of the ultraviolet ionization spectrum. For a photon number spectrum that falls off as ν^{-1} there is a diffuse ionization structure and for a spectrum that falls off like ν^{-4} there is a more classical Strömgren-like behavior with a half-width an order of magnitude smaller than in the ν^{-1} case. The basic equations are also presented for a more general class of spectral indices as well as a power law behavior of the total density on distance from the ionization source. (auth)

45228 SPECTRA OF THE PULSARS CP 0950 AND CP 1133 IN THE FREQUENCY RANGE 83 TO 111 MHz. Brezgunov, V. N.; Udal'tsov, V. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 9-12(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 14-18(Jan-Feb 1971).

Spectra are reported for series of pulses from the pulsars CP 0950 and CP 1133 in the frequency range 83 to 111 MHz. For each pulsar it is shown that the pulse spectra are not identical but vary strongly with time. Many of the pulses observed within a single minute exhibit a characteristic type of spectrum, which changes considerably after one day. Furthermore the spectra suffer sharp variations from the characteristic type to an anomalous type and conversely, taking place frequently and with discrete jumps. The rotation of the polarization plane at 83 MHz relative to 111 MHz cannot exceed 2 rad in the interstellar medium in the direction toward CP 0950, and it would be less than 2.5 rad in the ionosphere on winter nights. Rotations of this magnitude could not be responsible for the variations observed in the spectrum. Nor can the variations be explained by the influence of inhomogeneities in the electron concentration of the interstellar medium. The spectrum variations presumably are associated with the effects of radio-wave propagation in the envelope of the pulsar or with the physics of the pulsar radiation. (auth)

45229 ESTIMATION OF THE INTENSITY OF THE CRAB NEBULA'S SCINTILLATING COMPONENT IN THE 3.5 TO 7.5-m RANGE. Antonova, T. D.; Panadzhyan, V. G.; Pynzar, A. V. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 13-16(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 19-23(Jan-Feb 1971).

Experimental data are presented on the scintillation of the radio source 3C 144 at the wavelengths 3.5, 5, and 7.5 m, due to nonuniformities in the interplanetary plasma. Through comparison of the curves representing the amplitudes of scintillation of the sources 3C 144 and 3C 48, flux intensities of the scintillating component of the Crab Nebula are estimated. The spectral index of this component is 1.8. (auth)

45230 REGULAR VARIATIONS IN OPTICAL EMISSION OF QUASARS AND X-RAY SOURCES. Lukatskaya, F. I. (Main Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 23-5(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 32-4(Jan-Feb 1971).

Analysis of simultaneous UBV observations of seven radio sources and two x-ray sources shows that their U, B, and V values are related by linear regression correlations. The objects group in two regions on the $\Delta V/\Delta B$, $\Delta U/\Delta B$ plane, near the regions where novae and supernovae group after outbursts. Each group contains both radio and x-ray sources. (auth)

45231 COMPTON SELF-ABSORPTION ACCOMPANYING THE INDUCED COMPTON EFFECT. Charugin, V. M. (Inst. of Cosmic Research, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 26-8(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 35-8(Jan-Feb 1971).

The analogous features of synchrotron radiation and Compton scattering by relativistic electrons indicate the existence of Compton self-absorption. Suitable approximations are made to calculate the Compton self-absorption coefficient for the scattering of radiation of density ρ by relativistic electrons of density $N(E) = KE^{-n}$. The radiation flux scattered by these electrons is shown to have a cutoff at the self-absorption frequency ν_r; here $F(\nu) \propto \nu^{-}$ $(n-1)/2$ for $\nu > \nu_r$ and $F(\nu) \propto \nu^{5/2}$ for $\nu < \nu_r$. It is shown that all the Compton self-absorption equations can be obtained from the synchrotron self-absorption equations if the Compton scattering is treated as the synchrotron radiation of virtual gyrophotons by relativistic electrons in a magnetic field $H_\perp = (8\pi\rho)^{1/2}$. It is shown that it is important to take into account these results in quasars, the nuclei of Seyfert galaxies, and pulsars characterized by small size and an intense flux of relativistic electrons. (auth)

45232 POSSIBLE DISCRETIZATION OF QUASAR REDSHIFTS. Karlsson, K. G. (Uppsala Univ.). Astron. Astrophys.; 13: No. 3, 333-5(Aug 1971).

A number of new peaks in the distribution of redshifts of quasars were found. These, together with the well known peaks at $z = 1.956$ and $z = 0.061$, form a geometrical series. (auth)

45233 NEUTRON STAR MODELS AND PULSARS. Chanmugam, G.; Gabriel, M. (Univ., Liege). Astron. Astrophys.; 13: No. 3, 374-9(Aug 1971).

Neutron star models are constructed with the Nemeth–Sprung equation of state. Their dynamical stability is also discussed. It is suggested that the Crab pulsar has a central density $>5 \times 10^{14}$ gm cm^{-3}. (auth)

45234 OH OBSERVATIONS AT POSITIONS OF T TAURI STARS IN THE TAURUS–AURIGA REGION. Gahm, G. F. (Stockholm Observatory); Winnberg, A. Astron. Astrophys.; 13: No. 3, 489-92(Aug 1971).

The positions of some of the T Tauri stars in Taurus and Auriga were searched for OH 18-cm radiation with the 25.6-m radio telescope of Onsala Space Observatory. Positive results were obtained for SU Aur and RY Tau at 1667 MHz. The OH velocities are in agreement with results found for the general interstellar field, i.e., approximately +6 km/s. Radial velocities of T Tauri stars and dust clouds are discussed. Several T Tauri stars were observed at 1612 MHz with negative results to upper limits between 1.2 and 2.3 f.u. of observed flux density. (auth)

45235 SHORT-TERM STABILITY OF THE CRAB PULSAR. Pfleiderer, J. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 13: No. 3, 496-7(Aug 1971).

From two day's observations of the Crab pulsar, the distance of the observing telescope from the Earth's axis of rotation was derived to within 0.6 km of its true value, with 1.5 km standard error. The result implies that the short-term stability of the pulsar was equal to or better than 5 μs in about 5 hours, and 15 μs in 24 hours. (auth)

45236 NON-SOLAR X- AND GAMMA-RAY ASTRONOMY. Conference Held in Rome, Italy, May 8–10, 1969. Gratton, L. (ed.). International Astronomical Union, Symposium No. 37. New York; Springer-Verlag New York Inc. (1970). 433p. $23.10. (CONF-690564).

A discussion of observational techniques, including those that are planned for future work, is given. Other subjects dealt with are: the results on individual x-ray sources and on the diffuse background; the relation of x-ray stars to other galactic objects; the physical phenomena responsible for the strong x-ray emissions by the discrete sources; and background radiation. (W.D.M.)

Solar Phenomena

Refer also to abstract 45317.

45237 (AD–715131) SECTOR STRUCTURE OF THE SOLAR MAGNETIC FIELD. Wilcox, John M. (California Univ., Berkeley. Space Sciences Lab.). 13 Oct 1970. Contract N00014-69-A-0200-1016. 20p. NTIS.

The solar sector structure consists of a boundary in the north–south direction such that on one side of the boundary the large-scale weak photospheric magnetic field is predominantly directed out of the Sun, and on the other side of the boundary this field is directed into the Sun. The region westward of a solar sector boundary tends to be unusually quiet and the region eastward of a solar sector boundary tends to be unusually active. This tendency is discussed in terms of flares, coronal enhancements, plage structure, and geomagnetic response. (auth) (USGRDR)

45238 (AD–716472) FURTHER RESULTS ON O VII X-RAY CORONAL LINE EMISSION. Report for May–October 1970. Rugge, Hugo R.; Walker, Arthur B. C. Jr. (Aerospace Corp., El Segundo, Calif.). 14 Dec 1970. Contract F04701-70-C-0059. 14p. (SAMSO-TR-70-430). NTIS.

Measurements of the intensity ratio of O VII solar x-ray emission lines were made during a three-day period in 1969. The results are essentially the same as obtained from a different

satellite during an extended period in 1966/1967. These results lead to an upper bound on the coronal electron density from the regions emitting the O VII radiation of $\sim 5 \times 10^9$ cm^{-3}. (USGRDR)

45239 (AD-720244) ARBITRARY AMPLITUDE MAGNETO-ACOUSTIC WAVES UNDER GRAVITY: AN EXACT SOLUTION. Report for June-December 1970. Chiu, Yam T. (Aerospace Corp., El Segundo, Calif.). 15 Mar 1971. Contract F04701-70-C-0059. 35p. (SAMSO-TR-71-36). NTIS.

Exact Riemannian wave solutions were obtained to the magnetohydrodynamic equations for a compressible medium under the influence of a gravitational field. The method of solution consists of an application of Hamburger's subsidiary equations previously found useful in the analysis of such three-dimensional waves in compressible hydrodynamics under gravity. The resultant magneto-acoustic waves cannot be classified as slow and fast modes, and their propagation characteristics are found to be quite different from those in a uniform medium. In particular, the phenomenon of large-amplitude wave ducting is examined. Certain wave properties correspond exceedingly well with the observed fine structure of waves propagating away from solar flares. (auth) (USGRDR)

45240 (LA-DC-12495) RESULTS OF POLARIZATION OBSERVATIONS OF THE OUTER CORONA FROM A JET AIRCRAFT. Keller, C. F. (Los Alamos Scientific Lab., N. Mex.). [1970]. 11p. (CONF-710615-1). Dep. NTIS.

From fourteenth COSPAR meeting; Seattle, Wash. (17 June 1971).

Observations were made from an NC-135 aircraft at 36,380 ft over the Gulf of Mexico just off the coast of Mexico. White-light photographs were taken from a stabilized camera; four each were made for six exposure times ranging from 1.0 to 10.0 seconds; three each were made through plane Polaroid filters whose orientation was varied at 60° intervals. One streamer was recorded at 13 $R_\odot$ and six others could be seen beyond 7 $R_\odot$. (W.D.M.)

45241 SOLAR PROMINENCES AND THEIR MAGNETIC FIELDS. I. Tandberg-Hanssen, E. (National Center for Atmospheric Research, Boulder, Colo.). Sky Telesc.; 42: No. 2, 72-5(Aug 1971).

A brief review is given on the formation of quiescent and active prominences. The Zeeman effect is explained and problems of interpretation are mentioned. (W.D.M.)

45242 COROTATING PLASMA STREAMS REVEALED BY INTERPLANETARY SCINTILLATION. Houminer, Z. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Nature (London) Phys. Sci.; 231: No. 25, 165-7(21 Jun 1971).

Daily observations of four radio sources during January and February 1971 provided convincing evidence that variations in the scintillation index, which are not obviously associated with other activity, can be explained in terms of plasma streams corotating about the Sun. (auth) (UK)

45243 SUN AND THE INTERPLANETARY MEDIUM. Blackwell, D. E. Quart. J. Roy. Astron. Soc.; 11: No. 396-402 (Dec 1970).

After a brief mention of instruments and problems of their design the solar atmosphere is considered in some detail in this lecture. Recent advances in solar research are noted. (W.D.M.)

45244 PERIODIC SOLAR FLARE X-RAY EMISSION. Fehlau, P. E. (Los Alamos Scientific Lab., N. Mex.); Chambers, W. H.; Fuller, J. C.; (and others). Nature (London); 232: No. 5305, 42-3(2 Jul 1971).

An apparent 6-min periodicity in x-ray flares observed in the 0.1- to 0.3-nm wavelength band was reported in 1967, using a soft x-ray sensor on the satellite OSO-IV. The present communication describes a similar search using scintillation detectors on the satellites Vela V (1969) and Vela VI (1970); these searches did not confirm the 6-min periodicity. The alleged periodicity in the OSO-IV data could not be explained. (UK)

45245 SOLAR-WIND ACCELERATION CAUSED BY THE GRADIENT OF ALFVEN-WAVE PRESSURE. Alazraki, G.; Couturier, P. (Observatoire, Meudon, France). Astron. Astrophys.; 13: No. 3, 380-9(Aug 1971).

To investigate the possibility of an additional acceleration of the solar wind due to the presence of Alfvén waves propagating outward from the Sun, a stationary, spherically symmetric model was studied. A radial wind flow and also a radial field were assumed. The variations of the temperature are described by a polytrope law. The equation for the propagation of energy associated with Alfvén waves and the momentum flux conservation equation are coupled by a quadratic term in the amplitude of the wave which describes the gradient of magnetic pressure due to the perturbations. The variations of the solar-wind velocity with the radial distance were deduced for different values of the coronal parameters: temperature, magnetic field, and energy density in the form of Alfvén waves. It is shown that the acceleration of the solar wind due to the wave pressure gradient is important provided the wave energy density is sufficient (about 10^{-6} J/m^3 at 1.4 $R_\odot$). (auth)

45246 INVERSION IN SENSE OF CIRCULAR POLARIZATION WITH RESPECT TO FREQUENCY FOR SOLAR MICROWAVE BURSTS. Scalise, E. Jr.; Basu, D.; Marques Dos Santos, P. (Univ. Mackenzie, Sao Paulo, Brazil). Astron. Astrophys.; 13: No. 3, 471-7(Aug 1971).

Inspection of circular polarization data of solar radio bursts at 9400, 3750, 2000, and 1000 MHz over 1957-69 revealed that the polarization sense of a burst may reverse with respect to frequency once (single inversion) or twice or thrice (multiple inversion) between 9400 and 1000 MHz. Analysis of single inversion events shows that (i) inversion is most frequent between 3750 and 2000 MHz; (ii) the influence of the phase of solar cycle is not appreciable at lower frequencies; (iii) inversion is more favored as the source approaches the center of the solar disk both in heliographic latitude and longitude particularly at higher frequencies; (iv) a tendency of east-west asymmetry is exhibited which is opposite at successive sunspot cycles; (v) the relative distribution of the two senses of inversion (right-to-left and left-to-right) is similar in northern and southern hemispheres of the Sun during each solar cycle, but opposite senses of inversion predominate at successive cycles; (vi) there is no preferred position on the solar disk for either sense of inversion. Multiple inversion events, very few in number, may be associated with double sources, both producing radio bursts simultaneously. (auth)

45247 NONLINEAR COUPLING BETWEEN THERMAL CONDUCTION AND RADIATIVE TRANSFER. Frisch, H. (Observatoire, Nice). Astron. Astrophys.; 13: No. 3, 359-66(Aug 1971).

The problem of coupled thermal conduction and radiative transfer is solved numerically for a plane slab, of finite thickness, heated by thermal conduction, the temperatures at the boundaries and the radiation entering the slab being given. The absorption coefficient is taken of the form T^{-n}, where T is the temperature and n a positive number. An iterative method is used to solve this nonlinear differential problem. In the optically thick case a simple interpretation of the solution can be given in terms of a region of pure radiative equilibrium and transition regions where absorption (but not emission) of radiative energy is negligible. (auth)

45248 NUMERICAL CALCULATIONS OF ATOMIC STRUCTURE CONSTANTS. I. ANGULAR PARAMETERS. Bely, Francoise (Observatoire, Nice). Astron. Astrophys.; 13: No. 3, 336-44(Aug 1971).

A description is given of a numerical method of obtaining the expression of the H matrix of complex including spin-orbit interaction and configuration mixing. The matrix elements are expressed in terms of Slater and spin-orbit integrals. As an example the configurations s^2p^2, s^2d^2, p^2d^2, p^4, sp^3, s^2pd, and spd^2 are studied with special emphasis on the case of Fe XIII. The program can be used for atoms having up to nine electrons outside closed shells. (auth)

45249 WAVELENGTHS OF SOME RESONANCE AND CHARACTERISTIC X-RAY LINES. Vainshtein, L. A.; Safronova, U. I. (Lebedev Inst. of Physics, Moscow. Inst. of Spectroscopy, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 175-6(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 223-5(Jan-Feb 1971).

Coefficients are tabulated for series expansions, in powers of Z, of the energy of the 1s-2p, 2s, and 3p transitions in He-, Be-, and F-like ions, as well as the wavelengths of these transitions for the ions of elements abundant in the solar corona. (auth)

45250 TURBULENCE SPECTRA OF THE SOLAR CORONAL PLASMA AND THE STRUCTURE OF A RADAR SIGNAL. I. Gordon, I. M.; Liperovskii, V. A.; Tsytovich, V. N. (Inst. of Radiophysics and Electronics, Kiev. Inst. of Space Research, Moscow. Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 54-63(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 70-83(Jan-Feb 1971).

Under the assumption that a radar signal reflected from the Sun is formed through four-plasmon scattering processes on Langmuir pulsations of the coronal plasma of type $t + l \rightarrow t' + l'$, the structure of the signal spectrum is ascertained. It is also assumed that the Langmuir pulsations scattering the electromagnetic waves are generated in an isotropic isothermal plasma, and that their spectrum is stationary. It is demonstrated that the structure of the spectrum of a 38-MHz radar signal is in harmony, in its basic features, with theoretically predicted spectra when plausible values of the electron temperature are assigned. In the later discussion, the results obtained are extended to the case of a nonisothermal and anisotropic plasma. (auth)

XUM

45251 DETERMINATION OF THE VIBRATIONAL TEMPERATURE IN THE PHOTOSPHERE OF THE SUN FROM THE WEAK BANDS OF THE CN VIOLET SYSTEM. Porfir'eva, G. A.; Sitnik, G. F. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 64-70(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 84-91(Jan-Feb 1971).

The vibrational temperature in the photosphere of the Sun was determined from the $v' - v'' = 0$-1, 1-2, 2-3, 3-4, and 4-5 bands of the CN molecule, which belong to the violet system($B^2\Sigma^+$ electron transition). It was 4760 ± 270°K for the center of the Sun's disk and was equal, within the limits of error of the determination, to the rotational temperature determined previously from the $v' - v'' = 0$-1, 1-2, and 2-3 bands (4780 ± 130°). (auth)

45252 PROFILES OF LINES IN THE ACTIVE AND UNDISTURBED PHOTOSPHERE. Badalyan, O. G.; Livshits, M. A. (State Astronomical Inst., Moscow. Inst. of Geomagnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 71-5(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 92-7(Jan-Feb 1971).

Differences in the profiles of some lines in the active and undisturbed photosphere were determined from observations made with the horizontal solar research facility of the Academy of Sciences of the Ukrainian SSR, using a double-diffraction spectrograph. Lines whose formation levels lie rather deep in the photosphere were selected for the work. It was found that the difference in the central depths of the lines is ≈2 to 3% (with maximum as high as 6%) when the spectrograph slit is $1'' \times 20''$, and this difference seems to narrow down with further depth in the photosphere. Electronic computer calculations show that the observed effect can be accounted for in terms of overheating of the surface layers such that $\tau < 0.03$ at 100 to 150°C. (auth)

45253 INVESTIGATION OF PHYSICAL CONDITIONS IN A FLOCCULUS. Polupan, P. N. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 76-86(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 97-109(Jan-Feb 1971).

As a result of solving stationary equations for seven levels and ionization equilibrium, the following parameters of state of floccular material were found: $T_e = 7350°$, $N_1 = 5.4 \times 10^{20}$, $n_e = 2.6 \times 10^{11}$, $L = 2.2 \times 10^8$ cm, and $Ln_e^2 = 1.6 \times 10^{31}$. The initial data were populations taken on the levels 2 to 9 of hydrogen atoms, based on previous observational data. It is shown that the radiation in the first lines of the Balmer, Paschen, and Brackett series stems mainly from cascade transitions and from resonance scattering of photospheric radiation. Ionization-induced radiation is traced primarily to the 1st level. Ionization by electron impact becomes important starting with the 9th level. The degree of ionization is 0.10. The filling factor of the floccular space along the line of sight is 0.15. (auth)

45254 EMISSIVITY OF THE SOLAR ATMOSPHERE. Shmeleva, O. P.; Nikol'skii, G. M. (Inst. of Geomagnetism, the Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 87-8(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 110-12(Jan-Feb 1971).

On the basis of predictions and identification of short-wavelength lines in the solar spectrum, and the theory of ionization of the solar atmosphere, the specific emissivity P/N_e^2 of the solar atmosphere plasma is calculated semi-empirically as a function of temperature in the range from 3×10^4 to 3×10^6 °K. When $T < 4 \times 10^5$ °K, the P/N_e^2 ratios are a whole order of magnitude below those reported by Pottasch. The P/N_e^2 ratios undergo practically no change over a broad range from 5×10^4 to 2×10^6 °K. (auth)

Galaxies

Refer also to abstracts 44312, 45190, and 45192.

45255 (NYO-844-84, pp 44-7) CHRONOLOGY OF GALACTIC HEAVY-ELEMENT NUCLEOSYNTHESIS. Kohman, Truman P.; Huey, James M. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry).

In Nuclear chemistry and geochemistry research.

Calculations of the time dependence of r-process nucleosynthesis in the Galaxy described in last year's report (NYO-844-81) are revised and extended. (W.D.M.)

45256 STELLAR DISTRIBUTIONS AT HIGH GALACTIC LATITUDES. Schreur, Julian J. Tucson, Ariz.; Univ. of Arizona (1971). 200p. University Microfilms Order No. 71-14,507.

Thesis.

A photographic four-color system was applied to a study of the stellar distributions in Selected Areas 56 (l = 199°, b = 79°), and 27 (l = 175°, b = 28°). It was found to be a significant improvement over the three-color (RGU) system, because the addition of the fourth color made it possible to discriminate between giants and dwarfs of spectral types F, G, and K. The four-color indices were used to separate the stars in each of the two survey fields into four groups: the halo giants and dwarfs, and the disk giants and dwarfs. Space densities at various distances from the Sun were computed for each group. The density gradient of the halo giants in SA 56 was found to be very similar to the r^{-3} density gradient exhibited by the RR Lyrae variables near the north galactic pole. The space densities of the halo giants were found to be approximately 100 times those of the halo component of the RR Lyrae variables. The space densities at a given z-distance in the direction of SA 27 were found to be 0.7 times those at the same z-distance in SA 56. This result was obtained directly from the star counts by the use of the Oort–Vashakidse method of computing relative space densities, and also by the use of a modified Oort–Vashakidse method. The same result was obtained from a density analysis based on the four-color photometry. The ratio of space densities found at a given z-distance in the two fields, when coupled with the r^{-3} density gradient found for SA 56, leads to the conclusion that the surfaces of equal space density are inclined to the galactic plane by five degrees, in the sense that the equidensity surfaces approach the galactic plane in the direction of the galactic anticenter. (Diss. Abstr. Int., B)

45257 STRUCTURE OF BRIGHT GALAXIES AT 408 MHz. Cameron, M. J. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 439-60(1971).

Radio contours are presented for the bright spirals NGC 55, 253, 1566, 3521, 4945, 5236, and the bright E and SO galaxies NGC 1316, 1399, 4261, 4760, 4486, and 5128 observed with the Molonglo Cross. The observations of the bright spirals are compared with observations in the northern hemisphere as well as observations of the Galaxy, the Magellanic Clouds, and spirals such as NGC 300 whose emission is below the sensitivity limit of the instrument. In the case of the edge-on spirals NGC 253 and 4945, in particular, no evidence was found for a halo component similar to that postulated for the Galaxy. (auth) (UK)

45258 KINEMATICS AND STELLAR CONTENT OF POPULOUS CLUSTERS IN THE MAGELLANIC CLOUDS. Ford, Holland Cole. Madison, Wis.; Univ. of Wisconsin (1970). 157p. University Microfilms Order No. 71-289.

Thesis.

Image-tube spectra were obtained of twenty-six blue populous clusters and ten red globular clusters in the LMC and three globular clusters in the SMC. (TSS) (Diss. Abstr. Int., B)

45259 EXTRAGALACTIC X-RAY SOURCES AND ASSOCIATION OF GALAXIES. Cavaliere, A. G.; Gursky, H.; Tucker, W. H. (American Science and Engineering, Cambridge, Mass.). Nature (London); 231: No. 5303, 437-8(18 Jun 1971).

Evidence is presented for a class of intense x-ray sources correlating with associations of galaxies; the associated phenomena, including possibly the x-ray emission, extend well beyond the confines of one galaxy. Data from the direction of M87 show that more than a single source is involved, and other bright sources lie in regions where peculiar associations of galaxies are also found. Sources in Perseus and Coma, for which x-ray luminosities are in excess of 10^{44} ergs/s, are discussed; also sources in Virgo, where the source with an x-ray luminosity $\approx 5 \times 10^{42}$ ergs/S is close to M87. The radio galaxy NGC 5128 is also the centroid of a dispersing chain of galaxies. Some possibilities regarding the physical nature of these sources are discussed, including the fact that the dominant x-ray emission is localized and the possibility that the emission may be due to a superposition of individual galaxies comprising the associations; also, the possibility that the x-ray source is extended and has a thermal spectrum. (UK)

45260 RADIO LUMINOSITY FUNCTION OF BRIGHT GALAXIES. Cameron, M. J. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 429-37(1971).

The radio observations of 264 galaxies were used to calculate the radio luminosity function of bright galaxies at a frequency of 408 MHz. This was compared with the luminosity function derived from the identified sources of the 3C catalogue. The two results are in approximate agreement above a luminosity of $\sim 10^{21}$ W Hz^{-1} ster^{-1} but below this value the present results show a sharp break in the form of the function. (auth) (UK)

45261 CALCIUM AND SODIUM ATOMS IN DIELECTRIC INTERSTELLAR GRAINS. McIntyre, H. A. J.; Williams, D. A. (Univ. of Salford, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 13P-18(1971).

The shifts of calcium and sodium atom resonance lines caused by various dielectric environments are calculated and compared with the unidentified interstellar absorption at 4430 Å. The systems are unlikely to be the carrier of 4430 Å. (auth) (UK)

45262 SEARCH FOR NEAR-INFRARED EMISSION OF INTERSTELLAR MOLECULAR HYDROGEN. Gull, T. R.; Harwit, M. O. (Cornell Univ., Ithaca, N. Y. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 168: No. 1, 15-27 (15 Aug 1971).

A search for interstellar molecular hydrogen (H_2) by detection of emission lines within the 3−0 vibrational band was unsuccessful. No emission lines attributed to H_2 were detected in spectra of regions associated with the Orion Nebula, IC 5146, NGC 2264, or IC 1499, or in the close vicinity of ξ Persei. The experiment did not agree with the suggestion by Werner and Harwit that a weak emission feature of the dark bay associated with the Orion Nebula represents the O(2) 3−0 line of H_2. At present their alternate interpretation involving a high-velocity cloud emitting the P12 line cannot be ruled out. The interstellar H_2 recently detected by Carruthers in the ultraviolet spectrum of ξ Persei did not have detectable 3−0 band emission. For each source the present experiment set an upper limit to the column density of ultraviolet-excited H_2 molecules that return to the ground electronic state. (auth)

45263 KINEMATIC-DYNAMO THEORY. III. THE EFFECT OF TURBULENT DIFFUSIVITY IN THE DYNAMO EQUATIONS. Lerche, I. (Univ. of Chicago). Astrophys. J.; 168: No. 1, 115-21(15 Aug 1971).

The kinematic-dynamo equations, developed previously for a constant diffusivity, are further generalized to include the effect of turbulent diffusivity. This generalization is necessary since current ideas concerning galactic, and solar, dynamo action indicate that turbulent diffusivity is larger than "classical" diffusivity by about three orders of magnitude. Accordingly it must be included if a better understanding is to be obtained of dynamo action in turbulent media. Some simple cases are worked through to illustrate the physical importance of turbulent diffusivity on dynamo action. (auth)

45264 SUPERMASSIVE DOUBLE GALAXY IN THE CLUSTER ABELL 1775. Chincarini, Guido; Rood, Herbert J.; Sastry, Gummuluru N.; Welch, Gary A. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 168: No. 1, 11-14(15 Aug 1971).

Spectrographic and photometric data are presented for the giant double galaxy in the cluster Abell 1775. Several independent pieces of evidence are offered to support the belief that the system is a stable physical entity. The two nuclei show a radial-velocity difference of approximately 1700 km s^{-1}, which when combined with a Hubble constant of 75 km s^{-1} Mpc^{-1} and the assumption of circular orbits leads to a lower mass limit of 2×10^{13} $M_\odot$. This does not suffer from the large uncertainties that affect mass estimates for single giant galaxies. The absolute visual magnitude to a surface brightness of 25.5 mag per square arc second is found to be −23.7, which yields a minimum mass-to-light ratio of 83 in solar units. (auth)

45265 INTERSTELLAR GAS DYNAMICS. Proceedings of the Sixth Symposium on Cosmical Gas Dynamics, Yalta, USSR, 8–18 September 1969. Habing, H. J. (ed.). International Astronomical Union, Symposium No. 39. New York; Springer-Verlag New York Inc. (1970). 405p. $25.00. (CONF-690981).

The book is divided in two parts: (I) Description and general theory of the interstellar medium and (II) Interaction of stars and interstellar medium. In part I there are reviews on: the present status of theory and observations of the interstellar gas; interstellar plasma physics; the interstellar magnetic field; and gas flow around stars and galaxies. In part II reviews are given on: overall mass exchange between stars and the interstellar medium; the role of supernovae; mass loss from stars; grains; molecules; and protostars. (W.D.M.)

45266 CONDENSATION OF HYDROGEN ON INTERSTELLAR GRAINS. Lee, T. J. (Royal Observatory, Edinburgh. United Kingdom Atomic Energy Authority, Abingdon, Eng.); Gowland, L.; Reddish, V. C. Nature (London) Phys. Sci.; 231: No. 26, 193-6(28 Jun 1971).

Vapour-pressure studies were made of various gas mixtures, providing information about the conditions required for the condensation of hydrogen in interstellar gas clouds onto solid grains. (auth) (UK)

45267 INTERSTELLAR DUST CLOUDS. Reddish, V. C. (Royal Observatory, Edinburgh). Nature (London); 232: No. 5305, 40-1(2 Jul 1971).

It is stated that failure, so far, to detect gaseous emission lines from circumstellar dust clouds raises the possibility that such clouds consist only of dust grains. This possibility has previously been largely discounted on the grounds that the relative diffusion of the grains and gas is low, requiring time scales that are too long and resulting in only partial separation of the components. It is pointed out, however, that a forced diffusion process will occur in clouds of grains and gas in which stars have formed, resulting in complete separation in a relatively short time. Atoms and molecules striking the grains in a well mixed cloud of gas and grains will momentarily stick on the surface and some will be semipermanently adsorbed. Radiation from a star formed in the cloud will photodesorb gas from the grain surfaces. The forced diffusion driven by the stellar radiation continues until there is complete separation of gas and grains, and in the case of a roughly spherical cloud with a central star this will ultimately result in a circumstellar dust cloud. The time scale for separation of the gas and grains in a circumstellar cloud 1 pc in radius is calculated to be $\sim 10^6$ years. (UK)

45268 IDENTIFICATION OF TYPE-I SUPERNOVA BANDS. Graham, W. R. M.; Duley, W. W. (York Univ., Toronto). Nature (London) Phys. Sci.; 232: No. 28, 43-6(12 Jul 1971).

At least ten identifications are proposed, on the basis of excellent agreement in wavelength and approximate correspondence in bandwidth between laboratory and supernova spectra, and a model is proposed that offers an explanation for the origin of the diffuse interstellar bands at 4430, 4770, and 4630 Å and that suggests that the diffuse band at 4880 Å arises from Ti isolated in a solid aromatic hydrocarbon. Other identifications include Mn−hydrocarbon, Ca−hydrocarbon and Na−hydrocarbon. It is pointed out that identification of the broad supernova bands that originate in dust before its dispersion in the interstellar medium could lead to an understanding of the nature of the interstellar dust component that produces the usual diffuse interstellar bands. The proposed model attributes the diffuse interstellar bands to the perturbed resonance transitions of metal atoms trapped in solid hydrocarbons on interstellar grains. (UK)

45269 PLANCK STELLAR VELOCITY DISTRIBUTION. IV. THE PHASE-DENSITY DISTRIBUTION. Shatsova, R. B. (Rostov-on-Don Teachers' Coll., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 99-112(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 126-45(Jan-Feb 1971).

With an empirical Planck stellar velocity distribution as a basis, the phase-density distribution is derived. For the lowest velocities this function asymptotically approaches a Maxwell−Gauss distribution; for the highest velocities, a Rayleigh−Jeans distribution. The case of a spherical velocity distribution is considered, as well as an ellipsoidal distribution involving two or three integrals of motion. Methods are developed for determining the phase-density parameters C_s, δ, and v_* from the stellar velocity distribution alone. If the parameter δ and its derivative are established, then the stellar velocity distribution can be described more precisely than by the one-parameter Planck law, and moreover the gravitational acceleration K_z, Kuzmin's constant C, the relative star density $\nu(z)/\nu(0)$, the mass density near the Sun, and other quantities can be determined. (auth)

45270 PECULIAR-VELOCITY DISPERSION OF GALAXIES. Karachentsev, I. D. (Kiev State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 171-2(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 219-21(Jan-Feb 1971).

An rms peculiar velocity $\sigma \approx 270$ km/sec is estimated for galaxies from measurements of objects with negative radial velocities. (auth)

45271 ATTEMPT TO EXPLAIN THE MOTIONS OF THE GAS IN THE CENTRAL REGION OF THE GALAXY BY EXPLOSIVE EVENTS IN ITS NUCLEUS. van der Kruit, P. C. (Sterrewacht, Leiden). Astron. Astrophys.; 13: No. 3, 405-24 (Aug 1971).

In a preceding article, features of masses outside the galactic plane presumably expelled from the nucleus of the galactic system were investigated. Here the possibility is investigated that the well-known expanding features in the galactic plane, such as the three-kpc arm, would be due to a similar expulsion. It appears that these can be explained as the result of an expulsion of matter from the nucleus some 12 to 13 million years ago in two opposite directions making an angle of 25° to 30° with the plane. The expulsion should have taken place with velocities up to 600 or 650 km/s, and the densities in the clouds must have been rather high, maybe as high as 10^3 to 10^4 atoms/cm^3. The nuclear disk of radius 0.75 kpc, which is not expanding, may have survived this activity. (W.D.M.)

45272 THREE-COLOR PHOTOMETRY OF A FIELD IN THE LARGE SAGITTARIUS CLOUD. Fuenfschilling, H. (Univ., Basel). Astron. Astrophys.; 13: No. 3, 454-70(Aug 1971).

In a field of 0.26 square degrees which is part of the well-known galactic window, 1400 stars down to a limiting magnitude of G = 16.5 mag were measured photometrically in the RGU system on 23 plates taken with the 48-inch Palomar−Schmidt. The interstellar

reddening in the field was studied by means of the two-color diagrams for stars in given intervals of apparent magnitude. There were local differences in reddening that led to a division of the field into two parts of equal size. The reddening as a function of distance is given. The result agrees with the reddening of the globular cluster NGC 6522. Because of the complicated behavior of the reddening function, the interpretation of the two-color diagrams presented some difficulties. In many cases the absolute magnitude of a main-sequence star taken from a calibrated two-color diagram was not single-valued. The late-type giants were identified according to three criteria down to G = 15.5 mag. Two different kinds of density function were calculated for main-sequence stars with absolute magnitudes between +2 and +7—a minimum function which includes only stars with a single-valued absolute magnitude, and a maximum function for all stars. For main-sequence stars with absolute magnitude brighter than +3, both functions showed a maximum at a distance of 1.3 kpc. The same maximum was shown by the late-type giants. It coincided with the position of the Sagittarius spiral arm. In all cases, the density functions for main-sequence stars with absolute magnitude fainter than +3 showed the highest value at the smallest distance at which the density exceeds three or four times the density in the solar neighborhood. Minimum and maximum luminosity functions were calculated for the two density maxima at 500 pc and between 1.0 and 1.6 kpc. The luminosity function seemed to be steeper there than that of van Rhijn. (auth)

45273 STRUCTURE OF INTERSTELLAR MATTER. II. A CORRELATION BETWEEN INTERSTELLAR GAS ABSORPTION AND DUST EXTINCTION? Rohlfs, Kristen (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 13: No. 1, 46-51(Jun 1971).

From the measured color excesses of O and B stars estimates for the visual extinction of 17 radio sources were derived. Comparing these with 21-cm absorption measurements by Radhakrishnan et al. (1971) and Clark (1965) a linear regression was obtained. The slope of this relation was used to determine the ratio of the gas density to the dust density in the obscuring clouds. A value of $\rho_H/\rho_d = 50$ was found. From the fact that the relation is approximately linear some constraints on the law of dust formation in the interstellar medium could be derived. (auth)

45274 RADIO HALO OF THE GALAXY. Razin, V. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 35-40(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 46-53(Jan-Feb 1971).

New data on the distribution of the brightness temperature of cosmic radio emission over the sky and data on the structure of the magnetic field in the local galactic arm are discussed in relation to the radio halo of the Galaxy. The analysis demonstrates that the Galaxy does not have an intense radio halo, so that the region in which cosmic radiation builds up must be limited to the galactic disk. A radio halo is apparently observed around the galactic nucleus, in which a source of cosmic electrons is continuously active in the central region of the Galaxy, with angular dimensions ±60° in longitude and ±30° in latitude relative to the galactic center. (auth)

45275 EQUILIBRIUM AND STABILITY OF THE GASEOUS COMPONENT OF THE GALAXY. Kellman, Sanford Alan. Berkeley, Calif.; Univ. of California (1970). 90p. University Microfilms Order No. 71-15,812.

Thesis.

The distribution of gas satisfying both the hydrostatic equilibrium and Poisson conditions with distance above the galactic plane is derived and compared with Schmidt's observations of the gas density at the galactic tangential points. The presence of simple one-dimensional equipartition magnetic and cosmic-ray components is introduced explicitly in the gas hydrostatic equilibrium equation. A theoretical expression is derived for the half-thickness of the equilibrium disk of galactic gas. A time-independent, linear, plane- and axially-symmetric perturbation analysis is performed on a plane-parallel layer of nonmagnetic, nonrotating gas. The stability of a self-gravitating isothermal gas disk threaded by a one-dimensional equipartition magnetic field is considered with respect to waves with motions in the $\bar{B}_e$–$\bar{g}$ plane and perpendicular to it. (TTS)(Diss. Abstr. Int., B)

Cosmology

45276 QUASARS, DUST, AND THE GALACTIC CENTRE. Lynden-Bell, D.; Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 4, 461-75(1971).

The black-hole model of galactic nuclei is used to discuss properties of quasars as proto-black holes in the middle of galaxies. Quasar lifetimes may be as long as ~10^8 years and masses will be of the order of 10^8 $M_\odot$. Dust in the neighborhood of black holes is sometimes driven from the accreted gas by radiation pressure. This may cause the dust often seen in exploding nuclei and the infrared radiation from the galactic center. Dust models for the galactic center are considered in detail, and it is suggested that there may be a central black hole currently emitting ~1.5×10^8 $L_\odot$ in the ultraviolet and blowing away a hot nuclear wind. Emission knots in the central regions probably contain prominent OB stars which would make the Galaxy later than Sb. Finally, critical observations are listed which could establish the existence of a large central mass in the Galaxy of so small a size that it must be associated with a black hole. (auth) (UK)

45277 UNIFORM MODEL UNIVERSE CONTAINING MATTER AND BLACK-BODY RADIATION. May, Thomas Leslie. Urbana, Ill.; Univ. of Illinois (1970). 60p. University Microfilms Order No. 71-14,861.

Thesis.

The recently discovered 3°K background radiation is assumed to be a remnant of the primeval fireball. The Robertson–Walker metric is adopted, and solutions to Einstein's equations for the cosmological problem are sought. The Universe is assumed to consist of matter of density ρ and pressure p and blackbody radiation of temperature T. Upon introduction of the parameters $\rho = p/\rho c^2$ and ϕ, defined by $dR/dt = cg(\phi)$, where $g(\phi) = (\cot \phi$ for k = 1, $1/\phi$ for k = 0, $\coth \phi$ for k = –1), uniform models of the Universe are found upon specification of ϵ as an explicit function of t or of ϕ. This is possible by means of the fundamental equation, an equation which is derivable from Einstein's equations and from which solutions to the cosmological problem with interacting matter and radiation may be obtained for the values k = +1, –1, or 0. It is neither necessary nor desirable to assume that the gas pressure is always zero. Further, the equation of state of the gas emerges from Einstein's equations once the additional condition is prescribed. The function E_m, which is the net rate of conversion of energy per unit volume from radiation to matter, is presumed to be negative in the recent history of the Universe. Previous investigators have pointed out that $E_m(t) < 0$ for "large" t, but it is not necessarily the case that $E_m(t) < 0$ for "small" t. No conclusion about the sign of $E_m(t)$ should be drawn for "small" t when the assumption of zero gas pressure is made, for this condition is not known to be valid in the early history of the Universe. Earlier results with $\epsilon = \epsilon(t)$ are generalized to obtain point-source and non-point-source models with k = +1, –1, or 0 and without the restriction of zero gas pressure. A new form of $\epsilon(\phi)$ is introduced which also enjoys the property $E_m(t) < 0$ for recent epochs. There are undoubtedly many forms of ϵ which will generate physically acceptable cosmological models for all three values of k. (Diss. Abstr. Int., B)

45278 RETROGRADE MOTION IN THE KERR METRIC. de Silva, L. N. K. (Univ. of Sussex, Brighton, Eng.). Nature (London) Phys. Sci.; 231: No. 24, 148-9(14 Jun 1971).

The Kerr metric is stated to be of interest in connection with the hypothesis that galactic nuclei may be collapsed quasars, and an interesting feature of time-like geodesics in the Kerr metric is discussed in this communication. Equations of motion for a particle in the equatorial plane of a rotating body are given, leading to the conclusion that a particle orbiting in the opposite sense to the rotation of the central body commences to orbit in the sense of that rotation under certain specified conditions. This may be a consequence of dragging of the local inertial frame. (UK)

45279 EFFECT OF COSMOLOGICAL EXPANSION ON SELF-GRAVITATING ENSEMBLES OF PARTICLES. Noerdlinger, Peter D. (Ames Research Center, Moffett Field, Calif.); Petrosian, Vahe. Astrophys. J.; 168: No. 1, 1-9(15 Aug 1971).

The possible expansion of clusters or superclusters of galaxies, of mean rest-mass density ρ_c, immersed in a Universe containing a gas of particles having zero rest mass and having energy density ρc^2, is considered. The Universe may also contain dust. It is shown that when $\rho > \rho_c$ the clusters or superclusters expand with the Universe, but if $\rho_c \gg \rho$ the expansion is reduced in the ratio ρ/ρ_c. It therefore seems unlikely that clusters of galaxies could have formed prior to the epoch corresponding to the redshift $z \approx 2$ if the present value of ρ exceeds 10^{-29} g cm^{-3}, unless most of this radiation was generated outside the clusters and subsequent to their formation. Superclusters, if they exist, will follow the expansion of a Universe of even lower energy density. (auth)

45280 ENERGY PROBLEMS IN EXTRAGALACTIC NEBULAE. Ryle, Martin. Quart. J. Roy. Astron. Soc., 11: No. 5, 429-42(Dec 1970).

Two problems relating to the energy of galaxies are discussed in this lecture. One is concerned with the early stages in their formation, where the mechanisms available for dissi-

pating the gravitational energy, first of the collapsing proto-galaxy, and subsequently of the collapsing proto-stars within it, have a profound influence on the rate of star formation. The other is related to the problem of supplying very large amounts of energy, which cannot be attributed to stellar nuclear reactions, but which are evidently needed in all types of galaxy. An attempt is made to show how these two problems may be closely linked. (W.D.M.)

45281 ISOTROPY OF THE 3K BACKGROUND. Henry, P. S. (Princeton Univ., N. J.). Nature (London); 231: No. 5304, 516-17(25 Jun 1971).

The 3K background radiation provides a frame of reference equivalent to that defined by the matter by which it was last scattered, and motion of the Earth relative to this extremely distant reference frame can be measured by observing the 24-hr anisotropy in the 3K background. A temperature anisotropy of 10^{-3}K corresponds to a speed of ~100 km/sec. Previous efforts to measure this anisotropy have given only the component in the Earth's equatorial plane, and an experiment is described to attempt to determine the right ascension, declination, and magnitude of the Earth's velocity vector by measuring the 24-hr anisotropy in the cosmic background. Measurements were made with an X-band Dicke radiometer carried to 24 km by balloon. Details are given of the experimental technique and data analysis, and data are tabulated for anisotropy parameters for different spectral indices. The data do not fit the hypothesis of an isotropic background. The results support the assertion of Conklin (Nature 222: 971(1969)) that there is no large motion of the local supercluster relative to the more-distant frame defined by the 3K background radiation. (UK)

45282 COSMOLOGICAL UPPER LIMIT ON THE TIME VARIATION OF G. Morganstern, R. E. (Lunar Science Inst., Houston, Tex.). Nature (London); 232: No. 5306, 109-10(9 Jul 1971).

Recent results (Shapiro et al., Phys. Rev. Lett., 26: 27(1971)) based on an analysis of radar echo time delays have set an experimental upper limit of $<3 \times 10^{-10}$ per year on the possible time variation of the gravitational constant, and theoretical calculations (Dicke, Science, 138: 653(1962)) for zero-pressure Friedman-type cosmologies gave the value $\approx 10^{-11}$ for flat space and $\approx 3 \times 10^{-11}$ for closed space. Some new results are reported, based on exact cosmological solutions that are valid for all epochs and that extend Dicke's theoretical bound to the case of pressure-filled cosmologies in flat space, and it is also shown that all Friedman-type BD (Brans–Dicke theory) are scalar-dominated at early epochs of the Universe. The results show that the introduction of pressure decreases the theoretical upper limit in the case of flat space and arguments are presented that this is also true for curved spaces. In principle, the limits placed on the variation of G can be translated into limits on the equation of state for expanding cosmic matter, and although all Friedman models indicate an extremely weak variation of G at the present epoch, the associated scalar energy density is dominant for early epochs; the scalar field may thus play an important role in collapse situations in general. (UK)

45283 FRESH LOOK AT THE COSMOLOGICAL SINGULARITY. Davidson, W.; Evans, A. B. (Otago Univ., Dunedin, New Zealand). Nature (London) Phys. Sci.; 232: No. 28, 29-31(12 Jul 1971).

Consideration is given to homogeneous Newtonian universes expanding or contracting with shear and rotation. It was concluded by Heckmann and Shucking (Astrophys. 38: 95(1955) and 40: 81 (1956); Astron. J. 66: 599(1961)) that collapse to a singularity could be avoided by the inclusion of spin. This view was contested by Narlikar (Mon. Not. Roy. Astron. Soc. 126: 203(1963)), who stated that it was not possible to obtain nonsingular finitely oscillating models on the basis of Newtonian theory. The analysis presented confirms that Narlikar was right on the basis of his assumptions, but that his argument was far from being valid and incorrect in regard to a vital point. The present authors pursued the analysis of Newtonian universes to greater depth and examined the evolutionary properties of representative solutions. Some of the results appear to be of interest in cosmology. (UK)

45284 VALUE OF THE COSMOLOGICAL CONSTANT. Byalko, A. V. (Inst. of Theoretical Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 179-80(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 227-9(Jan-Feb 1971).

The cosmological constant Λ appearing in Einstein's equations is assumed to be exactly equal to its critical value Λ_c, and the effective correction to it resulting from the primordial blackbody radiation is calculated. The time dependence of the radius of curvature is found to be the same as in the Lemaitre model. The value of the correction term is estimated to be 1.3×10^{-3}. (auth)

45285 VIBRATIONAL REGIME OF APPROACH TO A SPECIFIC POINT IN RELATIVISTIC COSMOLOGY. Belinskii, V. A.; Lifshits, E. M.; Khalatnikov, I. M. (Inst. of Physical Problems, Moscow. Inst. of Theoretical Physics, Moscow). Usp. Fiz. Nauk; 102: 463-500(Nov 1970). (In Russian).

The question of the presence and character of the physical singularity for time in the general cosmological solution of the gravitation equations was studied. The generalized Kasner equation, containing seven arbitrary functions of spatial coordinates (one less than in the general equation), is considered. The evolution of such a solution in time after the inclusion of the missing function as a perturbation is clarified further. As a result, a general equation was obtained with a physical singularity of complex vibrational character. Simplified models are found (for homogeneous spaces types VIII and IX according to Bianchi) containing this new type of singularity. The qualitative and also quantitative study of the character of the solution in homogeneous models is given, and also the probability-statistical approach to the investigation of the solution near the singularity is described. (tr-auth)

45286 EFFECTIVE TEMPERATURE OF COSMIC BLACKBODY RADIATION AT 3.58 mm. Kislyakov, A. G.; Chernyshev, V. I.; Lebskii, Yu. V.; Mal'tsev, V. A.; Serov, N. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 29-34(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 39-45(Jan-Feb 1971).

The results of an experimental investigation of the cosmic blackbody radiation at $\lambda = 3.58$ mm are given; the measurements were made by comparing the brightness of the sky with the brightness of two standard radiators having different temperatures. The apparatus and method adopted in the measurements are described. The latter were made in October 1968 and February 1969 at the high-altitude base of the Shternberg Astronomical Institute. The effective temperature of the blackbody radiation was found to be 2.4 ± 0.7°K. (auth)

45287 ULTRAVIOLET RADIATION IN THE UNIVERSE. Prilutskii, O. F.; Rozental, I. L. (Inst. of Cosmic Research, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 41-4(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 54-8(Jan-Feb 1971).

A calculation was made of the intensity of the ultraviolet radiation due to the inverse Compton effect between cosmic relativistic electrons and the cosmic blackbody radiation. It was found that the ultraviolet radiation fluxes in the energy region ~10 to 100 eV due to this process are high and amount to $\sim 10^4$ to 10^5 photon · cm^{-2} · sec^{-1} · sr^{-1}. (auth)

Planetary Phenomena

45288 TUMOR THEORY AS KEY TO EXPLANATION OF ENCRUSTATION AND SOLIDIFICATION OF MOON AND EARTH. Borchert, H. (Technische Univ., Clausthal-Zellerfeld, Ger.). Gerlands Beitr. Geophys.; 79: No. 6, 425-464(1970). (In German).

The cooling and solidification sequences involved in the formation of the Moon's crust are discussed in detail. (W.D.M.)

45289 STUDY OF THE SPECTRAL AND STATISTICAL PROPERTIES OF JUPITER IN THE DECAMETER REGION. Bozyan, Frank Arakel. New Haven; Yale Univ. (1969). 334p. University Microfilms Order No. 71-13,794.

Thesis.

Observations from the Bethany Station of the Yale Observatory and from a cooperative program with the Astrophysical Observatory, Kodaikanal, India, are presented. The observations made during the 1962 to 1965 apparitions are reduced to a catalog by techniques described. The catalog published contains 17,238.7 hours of observing time of which 9,461.0 hours were at 22.2 MHz and 6,795.9 hours were at 20.0 MHz. These comprise the most extensive homogeneous series of monochromatic synoptic data now available. Flux measurements were made at four frequencies, using an absolute scale established by observations with a calibration dipole, and by observing discrete sources whose signal-to-noise ratio is enhanced by a synthesis technique. The average flux from Jupiter at 22.2 MHz when active is 0.9×10^{-21} watts/m^2-Hz, and at 20.0 MHz is 1.12×10^{-21} watts/m^2-Hz. These measurements were made during the 1964 apparition, which may have been somewhat anomalous, judging by the occurrence statistics of that apparition compared to the other well-observed apparitions. Periodogram calculations are reported that indicate the average decameter rotation period is consistent with the microwave period 9h55m29.83s, although possibly significant differences are seen in the periods for radiation coming from Io and non-Io related regions. (TSS) (Diss. Abstr. Int., B.)

45290 SEARCH FOR X RAYS FROM THE PLANET JUPITER. Hurley, Kevin Christopher. Berkeley, Calif.; Univ. of California (1970). 77p. University Microfilms Order No. 71-15,798.

Thesis.

The existence of Jovian radiation belts has been established from radio astronomical measurements; thus Jupiter, like the Earth, should be a source of bremsstrahlung x rays, generated when electrons from the radiation belts precipitate into the ionosphere. Three separate calculations are made to estimate the flux of Jovian x rays at the Earth. These estimates range from 10^{-9} to 10^{-1} x rays/cm^2 sec in the energy range 30 to 100 keV. Actively collimated balloon-borne scintillation counters, employing a special phoswich anticoincidence technique, were flown a total of 5 times from Palestine, Texas. Jupiter was observed for a total of 133 minutes, and an upper limit to the flux of x rays present at the observation time is 9.8×10^{-4} x rays/cm^2 sec in the energy range 30 to 100 keV. However, due to the absence of decametric radiation at the time of the one successful flight, and the fact that no significant solar activity had occurred for several days previous to the flight, it is unlikely that any radiation was present at this time. (Diss. Abstr. Int., B)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 44501 and 45850.

45291 (BMBW-FBK-70-28, pp 399-422) PLASMA CONFINEMENT AND STABILITY WITH APPLICATION TO ION SOURCES OF ISOTOPE SEPARATORS. von Goeler, S. (Princeton Univ., N. J. Plasma Physics Lab.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

The following three problems of plasma physics encountered in ion sources are reviewed: the minimum pressure in discharges, the composition of multiply ionized atoms in plasmas, and the stability of drift waves in discharges in a magnetic field. (M.O.W.)

45292 (JINR-P9-5857) STATIONARY STATE OF THE CHARGED SELF-FOCUSING BEAM OF HIGH CURRENT. Bonch-Osmolovskii, A. G.; Surovtsev, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The properties of the relativistic self-focusing beams in the self-consistent field model are considered. The possible existence of the charged state of such beams is shown and the neutralization limits for the equilibrium conditions are established. (auth)

45293 ELASTIC SCATTERING OF SLOW ELECTRONS BY LITHIUM ATOMS IN THE POLARIZED-ORBITAL APPROXIMATION. Dai, Bui Tien; Stauffer, A. D. (York Univ., Toronto). Can. J. Phys.; 49: No. 12, 1670-9(15 Jun 1971).

The low energy elastic cross section for electrons incident on lithium atoms was calculated via the polarized-orbital method proposed by Temkin. The only further approximations made are the exclusion of core polarization and the use of frozen core Hartree–Fock wave functions. Quite good agreement with previous close-coupling calculations are obtained in the energy range 0.5 to 3 eV. Surprisingly, the threshold resonance behavior predicted by the close-coupling results is obtained when exchange is neglected, but not when the full polarized-orbital method is used. (auth) (Canada)

45294 ALTERNATIONS IN THE SECONDARY EMISSION OF MOLECULAR IONS FROM NOBLE METALS. Joyes, P. (Faculte des Sciences, Orsay, France). J. Phys. Chem. Solids; 32: No. 6, 1269-75(Jun 1971).

The secondary emission of molecular ions Cu_n^+ or Ag_n^- shows a steady alternation according to the parity of n. An interpretation is given of this phenomenon by studying the stability, the ionization potential, and the electron affinity of these clusters. These characteristics are directly related to the energy spectrum of the molecular levels. These spectra are calculated for the external s electrons by a tight-binding method. The results agree with the experimental effect. The model is extended to secondary ions of the X_n^+ type where X is any atom having two s external electrons. (auth) (UK)

45295 IONIC COMPONENT OF CATHODE SPUTTERING DURING BOMBARDMENT OF TUNGSTEN BY ALKALI METAL IONS. Adylov, A. A.; Veksler, V. I.; Reznik, A. M. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 6, 35-8(1970). (In Russian).

The role of carbide formation during secondary emission from a cathode was investigated at pressures ranging from 10^{-7} to 10^{-10} torr. By means of a mass spectrum of the residual gas ions obtained through electron collisions in the gas phase, it was established that at overloaded conditions of the ion source the following ions were generated: CO^+, O_2^+, CO_2^+, H_2O^+, O_2^{++}, CH_4^+, and C^+. Carbide formation on the surface of the target thus could not be excluded. For this reason the target was brought to 2300°K for 60 min without ion bombardment to allow a carbide layer to form. Following this, it was bombarded with a beam of 2100-eV Rb^+ ions at 2600°K, while measuring the W^+ ion current as a function of time. The results showed that there was no influence of contamination on the emission of secondary W^+ ions. (K.S.W.)

45296 EMPIRICAL EQUATION FOR THE BACKSCATTERING COEFFICIENT OF ELECTRONS. Tabata, T.; Ito, R.; Okabe, S. (Radiation Center of Osaka Prefecture, Sakai, Japan). Nucl. Instrum. Methods; 94: No. 3, 509-13(1971).

The backscattering coefficient η of monoenergetic electrons impinging normally on a thick target is found to be expressed by an empirical equation of the form $\eta = a_1/(1 + a_2\tau^{a_3})$, where τ is the incident kinetic energy in units of the rest energy of the electron and the parameters a_i (i = 1,2,3) are given by simple functions of target atomic number Z. Values of eight constants to express a_i are determined by least-squares fit to a total of 615 experimental points reported in 20 references. This equation is valid for $Z \geq 6$ in the energy region from about 50 keV to the highest energy of the existing experimental data (22 MeV), and the rms deviation of the experimental data from the equation is about 7%. (auth)

45297 ZERO-FIELD QUANTUM BEATS IN LYMAN-β RADIATION FROM BEAM-FOIL-EXCITED HYDROGEN ATOMS. Lynch, D. J.; Drake, C. W.; Alguard, M. J.; Fairchild, C. E. (Oregon State Univ., Corvallis). Phys. Rev. Lett.; 26: No. 20, 1211-13 (17 May 1971).

Zero-field quantum beats were observed in Lyman-β emission (1026 Å) from hydrogen atoms formed by beam–foil excitation, and the energy dependence of the magnetic-substate cross sections for n = 3, l = 1 states was determined for beam energies in the range from 230 to 500 keV/atom. (auth)

45298 AUTO-IONIZATION OF MOVING HELIUM ATOMS AFTER THEIR PASSAGE THROUGH THIN FOILS OF CARBON. Harrison, K. G.; Lucas, M. W. (Univ. of Sussex, Eng.). Phys. Lett.; 35A: No. 6, 402-3(12 Jul 1971).

Two groups of Auger electrons were observed during the helium–ion (He^+) bombardment of thin foils of carbon at incident ion energies between 66 and 320 keV. These occur with mean energies 33.4 and 38.2 eV and are believed to be related to KLL and KLM Auger transitions of helium, respectively. (auth)

Atomic and Molecular Properties

Refer also to abstracts 45185, 45248, 45249, 45935, and 46133.

45299 RESONANCE-NARROWED LAMB SHIFT MEASUREMENT IN HYDROGEN, n = 3. Fabjan, C. W.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Lett.; 36A: No. 1, 69-70(2 Aug 1971).

A separated-oscillatory-field technique was used in conjunction with a fast hydrogen beam to narrow the Lamb-shift resonance in hydrogen n = 3 and to make a precision measurement of this interval. The final result is S(H,n = 3) = (314.80 ± 0.052) MHz. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 45936 and 46104.

Collision Phenomena

Refer also to abstracts 44737, 44739, 45615, and 46374.

45300 (ORNL-4688, pp 102-9) ATOMIC AND MOLECULAR CROSS SECTIONS. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

Detailed comparison of the inelastic scattering resulting from the reactions of electron stripping and capture has shown that H and D have the same scattering cross section at the same center-of-mass energy. Simple impulse calculations suggest that the product of particle energy and scattering angle is a function of the inverse of the impact parameter to the lowest order. A neutral-particle spectrometer was constructed and calibrated to measure

the energy dispersion of neutrals escaping a plasma. The H conversion efficiency of the analyzer system increases from 7×10^{-4} at 0.15 keV to 3×10^{-2} at 10 keV for N_2 stripping at an effective target density of 0.0125 torr-cm. Comparing the conversion efficiency of D and H at the same velocity indicates that for energies greater than 0.35 keV the conversion is dominated by the stripping reaction, which scales as the velocity, and for energies less than 0.35 keV the conversion is dominated by the scattering, which scales as the energy. Similar results are found for hydrogen target gas. Preliminary results are presented for the use of an $SrBaNb_2O_6$ pyroelectric detector as a device for measuring the total energy escaping a plasma boundary. (auth)

45301 ONE-ELECTRON TRANSITIONS IN ATOMIC COLLISIONS. Dalidchik, F. I.; Ivanov, G. K. Zh. Prikl. Spektrosk.; 13: 363-4(Aug 1970). (In Russian).

Inelastic atomic collisions are considered. Integral equations (Faddeev type) describing the process, are transformed with the calculation of quasi-classicality of the relative motion of atoms in the system of the time-dependent differential equations of the usual form, but with impulse terms, and by the interactions between them. The system of equations is analyzed according to the model of independent transitions in the points of interaction of terms. In the wide range of energies examined, the process of breakup of negative ions and ionization of hydrogen-like atoms on collision with atoms of hydrogen or inert gases were investigated. (tr-auth)

45302 USE OF LOW-ENERGY ACCELERATORS FOR THE STUDY OF GAS PHASE ATOMIC COLLISION PHENOMENA. Gilbody, H. B. (Queen's Univ., Belfast). Nucl. Instrum. Methods; 92: No. 4, 517-21(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Various types of collision processes that can take place when ions or atoms from thermal energies to several MeV pass through a gas are considered. At keV energies the three principal categories are charge-changing collisions, ionizing collisions, and collisions involving excitation. Crossed-beam experiments can yield information in the difficult range between thermal energies and a few eV. The values of measured cross sections can be markedly affected by the excitation of beam or target, and several experiments of this type are described. (R.W.R.)

45303 POLARIZATION OF MOLECULAR IONS IN PENNING COLLISIONS. Schearer, L. D.; Riseberg, L. A. (Texas Instruments Inc., Dallas). Phys. Lett.; 35A: No. 4, 267-8(14 Jun 1971).

A Penning ionization collision between optically oriented helium $^3S_1$ metastable atoms and molecular nitrogen is shown to yield polarized N_2^+ ions in the electronically excited $B^2\Sigma_u$ levels as a result of the spin-conservation rule. These polarized ions are then available for the purposes of radio-frequency spectroscopy. (auth)

45304 PENNING EFFECT CROSS SECTIONS FOR COLLISIONS BETWEEN NOBLE GAS METASTABLES AND GROUP II ATOMS. Riseberg, L. A.; Schearer, L. D. (Texas Instrument Inc., Dallas). Phys. Lett.; 35A: No. 4, 269-70(14 Jun 1971).

Pulsed afterglow measurements of Penning ionization cross sections for mixtures of He, Ne, Ar, and Kr metastable atoms with Cd and Zn atoms are presented. The systematic behavior of the cross sections is discussed in the light of available theory. (auth)

45305 ENERGY DEPENDENCE OF THE SLOW-POSITRON ELASTIC SCATTERING CROSS SECTION IN HELIUM. Rodionov, S. N.; Sannikov, B. P.; Solodov, E. P. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 35A: No. 4, 297-8(14 Jun 1971).

The momentum-transfer cross section of slow positrons in helium was found to be constant in the energy region of 1 to 5 eV and equal to $(0.023 \pm 0.006)\ \pi a_0^2$. (auth)

45306 EXCITATION OF ATOMS BY ION BOMBARDMENT NEAR THRESHOLD ENERGY. Sheldon, J. W. (Florida State Univ., Tallahassee); Smotrel, J. R. Phys. Lett.; 35A: No. 6, 465-6(12 Jul 1971).

Expressions for the cross sections for the excitation of atoms by ion bombardment near threshold energy are obtained for dipole and quadrupole transitions in terms of the generalized oscillator strength for the transition and the ion–atom hard-sphere collision radius. (auth)

45307 MULTIPHOTON IONIZATION AND DISSOCIATION OF THE HYDROGEN MOLECULE AT 1.06 μ. Agostini, P.; Lu Van, M.; Mainfray, G. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 36A: No. 1, 21-2(2 Aug 1971).

Multiphoton ionization and dissociation of the hydrogen molecule were observed when hydrogen was irradiated by a neodymium glass laser. The order of the nonlinear processes and corresponding multiphoton probabilities were determined. (auth)

45308 CALCULATION OF EFFECTIVE CROSS SECTIONS FOR ELECTRON COLLISION EXCITATION OF THE FINE STRUCTURE COMPONENTS $^1P_1$ AND $^3P_{0\,1\,2}$ OF MERCURY, CADMIUM, AND ZINC ATOMS. Savchenko, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 1, 6-9(Jan 1971).

Translated from Opt. Spektrosk.; 30: No. 1, 12-18(Jan 1971).

The Born effective cross sections for excitation of the fine-structure components of Hg, Cd, and Zn were calculated in the intermediate-coupling approximation for low incident-electron energies. Satisfactory agreement with experimental data was obtained. (auth)

45309 CHARGE TRANSFER TO AN EXCITED STATE. Bylkin, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 6, 552-5(Dec 1970).

Translated from Opt. Spektrosk.; 29: No. 6, 1036-40(Dec 1970).

The phenomenon of charge transfer involving the formation of an ion in an excited state is treated in the two-level approximation. The exchange interaction is determined by the asymptotic method, and on this basis, and also on the basis of the Landau–Zener formula, a selection of ionic states excited with large cross sections is made. An expression is given for the calculation of the cross sections of the process. (auth)

Atomic Theory

45310 IMPROVED STATISTICAL ATOMIC MODEL. Gombas, P. (Univ. fuer Technische Wissenschaften, Budapest). Phys. Lett.; 35A: No. 6, 389(12 Jul 1971). (In German).

The electron density in the improved statistical model is zero in a small sphere surrounding the nucleus. The electron energies of the atoms agree excellently with the semi-empirical values. (auth)

45311 CONVERGENCE OF TIME-DEPENDENT PERTURBATION THEORY FOR AUTOIONIZING STATES OF ATOMS. Simon, B. (Princeton Univ., N. J.). Phys. Lett.; 36A: No. 1, 23-4(2 Aug 1971).

A rigorous proof of the convergence of the formulas from time-dependent perturbation theory in a variety of cases including Auger states is given. (auth)

Cosmic Radiation

Refer also to abstracts 44634, 44693, 45630, 45635, 45648–45651, 45655, 45662, and 45663.

45312 (AD-718439) UCSD COSMIC-RAY MUON ZENITH-ANGLE EXPERIMENT. Final Report. Masek, George E. (California Univ., Berkeley. Dept. of Physics). 13 Oct 1970. 18p. (AFOSR-70-2558-TR). NTIS.

Recent investigations into the zenith-angle dependence of very-high-energy (E > 1000 GeV) cosmic-ray muons have shown a discrepancy from what would be expected if the muons originate from pions and kaons, as is currently believed to be the case. If this discrepancy is confirmed it could have important implications concerning possibly a new particle or new process. The author designed and constructed a large cosmic-ray telescope to measure the zenith angle distribution of muons up to 6000 GeV. The apparatus is capable of observing 10 events a day with E > 1000 GeV and should be able to substantiate the above effect with about 9 months of running time. (auth) (USGRDR)

45313 (AD-720410) CHEMICAL COMPOSITION AND ENERGY CONTENT OF THE ENERGETIC COSMIC RADIATION. Waddington, C. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Mar 1971. Contract N00014-67-A-0113-0021. 26p. (CR-155). NTIS.

A brief survey was made of present knowledge of the composition and energy spectra of the primary cosmic radiation. The total energy carried by all forms of cosmic radiation that have appreciable penetrability into matter has been evaluated. This information, when combined with a knowledge of the rate at which the different components deposit energy in traversing matter, would permit calculations of the radiation dose that would result from exposure to the primary cosmic radiation. It is concluded that overall these radiation effects are rather small but it is emphasized that local damage can be of much greater significance. (auth) (USGRDR)

XUM

45314 (LUIP-CR-71-3) CHARGE IDENTIFICATION OF HEAVY PRIMARY COSMIC RAY PARTICLES BY MEANS OF NON-ELECTRON SENSITIVE ILFORD K-2 NUCLEAR EMULSIONS. Rosander, R. (Lund Univ. (Sweden). Dept. of Physics). Apr 1971. 62p. Dep. NTIS (U. S. Sales Only).

Charge resolution of heavy primary cosmic-ray particles in less-sensitive nuclear emulsions was investigated. Photometric mean track-width measurements on about 200 primary particles ($Z \geq 5$) stopping in an Ilford K2 emulsion stack were carried out. The measurements were corrected for different emulsion effects and a charge distribution is given. The standard deviation of the experimentally determined charge values amounted to about 0.30 units of charge for oxygen and to about 0.25 units for iron nuclei when the range interval 0.5 to 10.5 mm was used for the identification. The charge resolution was limited by grain-density fluctuations in the emulsion, which did not seem to have a completely statistical origin but instead seemed to depend on large-scale variations in the sensitivity of the emulsion pellicles. The resolution was comparable with the charge resolution obtained with other types of cosmic-ray detectors. The investigation indicated that less-sensitive nuclear emulsions are useful in the study of the heavier part of the cosmic-ray charge spectrum, especially as the exposure time can be extended as compared with electron-sensitive nuclear emulsions. (auth) (Sweden)

45315 DEPENDENCE OF THE P.P.P. EXPERIMENTAL MULTIPLICITIES ON THE PRIMARY ENERGY. Bergamasco, L. (CNR, Turin); Castagnoli, C.; Piano, A.; (and others). Lett. Nuovo Cim.; 1: No. 24, 1001-5(12 Jun 1971).

Multiplicities of parallel penetrating particles (p.p.p.) in high-energy muon showers were measured at 40 m.w.e. and their dependence on the primary nucleon energy was studied according to the isobar pionization modified to take account of the fireball motion. Results of singles and coincidence measurements are given. It is found that the p.p.p. multiplicity spectrum is strongly sensitive to the geometry of the apparatus, the errors of the theoretical intensity are mainly due to the uncertainty in the size spectrum, the agreement between the experimental data and the composite isobar model is very good for "small" detectors, and the primary energies involved are very high (10^{16} to 10^{18} eV). (R.W.R.)

45316 MODULATION OF COSMIC RAYS AS A FUNCTION OF HELIOLATITUDE: DETERMINATION OF NEUTRON MONITOR ANNUAL AND SEMI-ANNUAL PERIODICITIES USING A HYBRID SPECTRUM-TREND ANALYSIS TECHNIQUE. Schneider, Sydney H. New York; New York Univ. (1970). 249p. University Microfilms Order No. 71-15,430.

Thesis.

An investigation was undertaken to determine the nature of annual and semi-annual periodicities in neutron monitor data. An examination of the existing methods in time series analysis, including digital filtering and power spectrum analysis, revealed that a good method for resolving small amplitude, low frequency periodicities in the presence of considerable noise and trend was not available. A hybrid method of analysis was devised involving two steps. The analysis procedure was applied to the pressure-corrected neutron monitor data from eleven locations around the world, spanning the northern and southern hemispheres for a large part of the last solar cycle. Atmospheric pressure data from seven of these same sites was subjected to the same analysis to check for residual effects in the neutron monitor data. Some results of these analyses are given. (TSS) (Diss. Abstr. Int., B)

45317 RELATION BETWEEN THE GRADIENT OF COSMIC PARTICLES PERPENDICULAR TO THE SUN'S EQUATORIAL PLANE AND THE CORONA INTENSITY DURING 1968–1969. Trottet, Gerard (CNRS, Verrieres-le-Buisson, France). Compt. Rend., Ser. B; 272: No. 21, 1218-20(24 May 1971). (In French).

The variation of the perpendicular cosmic intensity gradient during 1968–1969 is related with that of the difference between the coronal intensities integrated over a 40° angle centered about the Earth heliolatitude when it is in the equatorial plane and at its extrema of ±7°15′ relative to this plane. (France)

45318 KOLAR GOLD FIELDS NEUTRINO EXPERIMENT. I. THE INTERACTIONS OF COSMIC-RAY NEUTRINOS. Krishnaswamy, M. R. (Tata Inst. of Fundamental Research, Bombay); Menon, M. G. K.; Narasimham, V. S.; (and others). Proc. Roy. Soc. (London). Ser. A; 323: No. 1555, 489-509(6 Jul 1971).

Final results are presented of an experiment to study the interactions of cosmic-ray neutrinos deep underground, at a depth of 7.6×10^5 g cm^{-2} (standard rock). Clear examples were recorded of neutrino-induced muons, including cases of upward moving particles and neutrino interactions within the detector assembly itself. The observed rate of events is compared with expectation and conclusions are made about the variation of the inelastic cross section with energy and the lower limit to the mass of the intermediate boson. An examination was also made of the celestial coordinates of the detected neutrinos and details are presented. (auth) (UK)

45319 KOLAR GOLD FIELDS NEUTRINO EXPERIMENT. II. ATMOSPHERIC MUONS AT A DEPTH OF 7000 hg cm^{-2} (KOLAR). Krishnaswamy, M. R. (Tata Inst. of Fundamental Research, Bombay); Menon, M. G. K.; Narasimham, V. S.; (and others). Proc. Roy. Soc. (London), Ser. A; 323: No. 1555, 511-22(6 Jul 1971).

An experiment was performed in the Kolar Gold Fields in Southern India to search for the interaction products of cosmic-ray neutrinos. In the course of four years operation of the detectors at a depth of 2316 m of rock, some 165 particles were recorded which were attributed to muons of atmospheric (as distinct from neutrino-) origin and the results of measurements on these particles are described. The measured vertical intensity at the depth in question (2316 m of Kolar rock corresponding to 7.6×10^5 g cm^{-2} of standard rock) is (1.1 ± 0.2) 10^{-6} m^{-2} s^{-1} sr^{-1}. Including measurements at shallower depths by other workers, from sites elsewhere in the same Gold Fields, a best fit to the data gives the relation $I(h) = 7.73 \times 10^{-3} \exp(-h/790)$ m^{-2} sr^{-1} s^{-1} for depth range $4000 < h < 9500$ hg cm^{-2} Kolar rock (1 hg cm^{-2} = 10^2 g cm^{-2}). An approximate estimate was made of the mean energy of the atmospheric muons at the depth of operation; its value, ca. 330 GeV, is not inconsistent with the expected value. (auth) (UK)

45320 OBSERVATION OF RADIO PULSES FROM EXTENSIVE AIR SHOWERS AT 3.6 MHz. Hough, J. H.; Prescott, J. R.; Clay, R. W. (Univ. of Calgary, Can.). Nature (London) Phys. Sci.; 232: No. 27, 14-15(5 Jul 1971).

It is stated that observations of radio emission from extensive air showers below 20 MHz are difficult to interpret because terrestrial noise, reflected from the ionosphere, is large compared with the magnitude of the radio pulses. At frequencies below 4 MHz, however, D-layer absorption during daylight may decrease the noise background sufficiently to enable more positive observation of the radio emission. Some earlier studies at low frequencies are first briefly reviewed, followed by a description of experiments made at 3.6 MHz at the University of Calgary in May and June 1970. The average shower rate was ~5/hr and the average shower size was $\sim 5 \times 10^5$ particles. Details are given of the experimental equipment and technique and of the method of data analysis. The field strength for the radio emission was calculated to be 300 μV/mMHz for showers of average size. This value is an order of magnitude greater than in the 20- to 60-MHz band, but is less by a factor of 3 to 4 than estimates at 2 MHz. (UK)

45321 OBSERVATION OF COSMIC RAYS AND OTHER GEOPHYSICAL PHENOMENA AT THE MIRNY OBSERVATORY DURING 1968. Sil'vestrov, L. V.; Checha, V. A. (Arctic and Antarctic Scientific Research Inst., Leningrad). Inform. Byull. Sov. Antarkt. Eksped.; No. 78, 46-53(1970). (In Russian).

The high solar activity during the second half of 1968 caused many geophysical phenomena in the magnetosphere and the upper atmosphere of the Earth. Variations in the neutron component of cosmic radiation and in the magnetic field and absorption in the polar cap, recorded during 1968 at the Mirny Observatory, were correlated with optical bursts and radio emissions of the Sun. The neutron component, recorded by means of standard neutron monitors at 22 m above sea level, was found to amount to 10^4 pulses/hr at an atmospheric pressure of 1000 millibar. The variations were expressed as percentage deviation from the mean value. Variations of the magnetic field were determined by means of the standard Eschenberg-type magnetographs. The solar activity was derived from optical and radioastronomical observations at the Moscow and Ottawa stations. The data will be used to gain additional insight into the corpuscular fluxes emitted by the Sun and about physical processes in the space near the Earth; they will be correlated with observations collected at other stations. (TTT)

45322 PROPAGATION OF COSMIC-RAY NUCLEI. de Freitas Pacheco, J. A. (Observatoire, Nice). Astron. Astrophys.; 13: No. 1, 58-64(Jun 1971).

The transfer equation for particles was solved for a very simple model taking into account the boundary conditions. The diffusion coefficient obtained in the calculations was about two or three orders of magnitude smaller than the usual value. The lifetime of M nuclei in the Galaxy is smaller than the time required to diffuse out from the Galaxy and smaller than the nuclear destruction time. Only for protons is the lifetime essentially equal to the diffusion time. (auth)

Direct Energy Conversion

Refer also to abstract 45340.

45323 (AD-720407) BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION. Technical Summary Report, December 1, 1969–November 30, 1970. Warner, Charles; Hansen, Lorin K. (Atomics International, Canoga Park, Calif.). Feb 1971. Contract N00014-70-C-0196. 197p. (AI-71-9). NTIS.

Basic processes in thermionic diodes were studied, and the application of this basic information to the achievement of practical thermionic energy conversion is discussed. The studies presented are: cesium adsorption measurements; cesium adsorption study using ellipsometry and Auger spectroscopy; cesium structure on tungsten; cesium adsorption theory at higher coverages; and nonsaturation phenomena in thermionic converter collector carbon deposits. (auth) (USGRDR)

45324 (N-71-12277) DEVELOPMENT OF THERMIONIC CONVERTERS. Final Report. Jacobson, Dean; Hamerdinger, Randy (Electro-Optical Systems, Inc., Pasadena, Calif.). Oct 1970. Contracts NAS7-100; JPL-952255. 322p. (NASA-CR-111578). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

Six ring-type cylindrical thermionic converters were designed, fabricated, and tested in an iterative manner during this developmental program. Converters with characteristic low power and high efficiency were designed to be capable of integration to form a modular power supply of high power output. The central philosophy of the approach was to increase the reliability of thermionic space power supplies by redundancy of the basic component. The improved cylindrical converters had an ultimate optimum performance of 3.86 watts/cm^2, at 0.50 volt, at a measured emitter temperature of 1400°C. The calculated interelectrode spacing at 1400°C was 12 mils. The final converter design featured a conical emitter envelope with a convolute for added strength, and a total converter thickness of 1.52 cm. The emitter and collector materials were CVD or wrought rhenium and the radiator was solid niobium. (auth) (STAR)

45325 TEMPERATURE STABILISATION SYSTEM. Busse, Claus; Schlitt, Karl (to EURATOM). British Patent 1,238,609. 7 Jul 1971. Priority date 5 Dec 1968, Luxembourg.

A system is described for temperature stabilization using a heat pipe. That zone of the heat pipe remote from the heating zone has an inert gas plug, the volume of which varies with the vapor pressure of the heat vehicle. The plug effects variation in the heat pipe wall area actually radiating heat, according to the changes in the volume of the plug. The system is characterized in that the part of the heat pipe where the inert gas plug is disposed is in good thermal connection with the heating zone of a secondary heat pipe. (M.H.R.)

45326 EXPERIMENTAL STUDY OF CHARACTERISTICS OF AN INDUCTION MHD MACHINE IN DIFFERENT REGIMES. Krishberg, R. R. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 84-7(1971). (In Russian).

The electrical characteristics of an induction-type MHD generator with a rotating conducting cylinder were studied experimentally. The formulas for plane-parallel fields in a nonmagnetic gap were used in a comparison study. It was found that, for a wide range of magnetic Reynolds numbers, the formulas for plane-parallel fields give sufficiently accurate results. (M.O.W.)

45327 SELF-EXCITATION OF ASYNCHRONOUS MACHINES WITH INCREASED NONMAGNETIC GAP. Krishberg, R. R. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 88-93(1971). (In Russian).

Conditions of the self-excitation of an asynchronous machine with increased nonmagnetic gap were studied. Correlations of the parameters $a = (r_1^2C/M)$ and $\sigma_1 = 1 + (L_s/M)$ are shown, where r_1 is the active resistance of the stator winding, C the excitation capacity, M the inductivity of the main magnetic flow of the machine, and L_s the inductivity of the stator dispersion flows. The calculated values are compared with the experimental ones under the conditions of no load. Conditions of self-excitation in the case of an induction MHD machine with current-conducting walls of the duct in nonmagnetic gaps are also established. The results can be used for calculation of self-excitation of asynchronous and induction MHD machines. (auth)

45328 PULSED MODEL OF A MAGNETOHYDRODYNAMIC GENERATOR HAVING A STRONGLY NONEQUILIBRIUM PLASMA. Golubev, V. S.; Malikov, M. M.; Nedospasov, A. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1185-92(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1265-73(Nov-Dec 1970).

An investigation was carried out of a model of a pulsed MHD generator with pronounced departure of the electron temperature from the gas temperature, which was ensured by the supersonic motion of the preionized gas in a strong magnetic field. The volt–ampere characteristics obtained for the generator correspond to a specific electric take-off power of 20 to 100 W/cm^3. This value of power, as well as the values of effective electrical conductivity, are in qualitative agreement with the phenomenological theory of a plasma having a turbulent conductivity in which the magnitude of the effective Hall parameter $\beta^* \sim 1$. (auth)

45329 BEHAVIOR OF THE ELECTRICAL INSULATION IN A MAGNETOHYDRODYNAMIC UNIT FOR OPERATION WITH ARGON–POTASSIUM PLASMA. Vanin, V. E.; Kirillov, V. V.; Sokolov, Yu. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1193-7(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1274-9(Nov-Dec 1970).

The results of an experimental investigation of the behavior of the electrical insulation of the walls of a magnetohydrodynamic generator channel and of the loop are presented for the "Start" unit for operation with argon–potassium plasma, which has a strong negative effect on the properties of the materials. It is revealed that the extent of effects of the impurity depends essentially on the temperature level of the surface of the channel-insulating elements. The temperature dependence of the surface conductivity of the insulating wall consisting of dense aluminum oxide was found for operation in contact with a stream of argon–potassium plasma. (auth)

45330 EXPERIMENTAL INVESTIGATION OF A CONSTANT-CURRENT MHD MACHINE WITH SEGMENTED ELECTRODES. Alad'ev, I. T.; Mukhin, V. A.; Strizhak, V. E.; Teplov, S. V.; Tolmach, I. M. Magn. Gidrodin.; No. 1, 64-72(Jan-Mar 1971). (In Russian).

Constant current MHD prototypes were constructed with segmented electrodes and a potassium loop. Pump and generator testing was conducted; and the following operating characteristics were noted: Temperature of liquid K = 160°C, voltage to the duct = 1.1 V, developed head = 4.05 atm., flow rate = 0.15 kg/sec, and efficiency = 7%. The difference between calculated and experimental data was in the range 10 to 15%. (K.S.W.)

45331 GENERAL ANALYSIS OF THE OPTIMUM MHD GENERATOR WITH A CONSTANT DUCT CROSS SECTION. II. OPTIMUM BOUNDARY CONDITIONS. Pleshanov, A. S.; Lazarev, P. P. Magn. Gidrodin.; No. 1, 73-6(Jan-Mar 1971). (In Russian).

The problem of the optimum linear-conduction MHD generator is investigated for the case of constant cross-sectional area. It was learned that with subsonic flow some optimum operating conditions of the MHD generator may be realized by two methods. The supersonic regime of operation, by comparison with the former, assures a higher power removal with a given volume of generator, which increases with decrease of relative heat capacity. (tr-auth)

45332 CALCULATION METHODS FOR CHARACTERISTICS OF LINEAR AND ARC INDUCTION MACHINES TAKING INTO ACCOUNT END EFFECTS. Vol'dek, A. I.; Tolvinskaya, E. V. Magn. Gidrodin.; No. 1, 84-90(Jan-Mar 1971). (In Russian).

Three variants of the conversion scheme are examined, taking into account the longitudinal end effect. Calculations were carried out to obtain the resistance of the longitudinal end effect of a machine in two situations. The calculated and experimental parameters of the end effect were compared, confirming the correctness of the basic premises assumed. (tr-auth)

45333 STUDY OF THE END EFFECTS IN LINEAR INDUCTION MHD MACHINES. Lazarenko, L. F. Magn. Gidrodin.; No. 1, 91-8(Jan-Mar 1971). (In Russian).

A numerical analysis was conducted of the electromagnetic power, force, and electric loss in a secondary medium caused by longitudinal end effects in working regimes in linear induction machines. Results are evaluated for the suppression of the longitudinal end effect in certain cases. It is shown that at the entrance and exit of a linear induction MHD machine, the longitudinal end effects appear differently, and their compensation by the media brought to a full or partial compensation of longitudinal edge effects at no-load operation, gives satisfactory results only for machines with a poorly conducting secondary medium. (tr-auth)

45334 QUALITATIVE ANALYSIS OF THE EFFECT OF INHOMOGENEITIES OF VERTICAL VELOCITY PROFILES IN THE CHANNEL ON THE PARAMETERS OF AN INDUCTION MHD MACHINE. Rashchenkin, A. P. Magn. Gidrodin.; No. 1, 99-105(Jan-Mar 1971). (In Russian).

The electromagnetic field distribution was investigated for a gap of a linear induction MHD machine, with the assumption that

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the velocity profile of the fluid flowing in the duct is constant with respect to the width of the duct, but varies with respect to the height according to a fixed relationship. The model was so chosen as to take into consideration the effect of electroconducting walls of the duct and a layer of thermal insulation. A formula was obtained for the basic electrical parameters of the machine. It was found that for a weak display of the end effect, the machine parameters to a first approximation may be determined from the value of the average velocity. It is essential to take into account the velocity profile with respect to the duct height in intensely powerful machines. (tr-auth)

45335 STUDY OF THE SHUNTING EFFECT OF CONDUCTING WALLS OF THE DUCT IN A PLANE INDUCTION MHD MACHINE. Vilnitis, A. Ya.; Yubels, E. V. Magn. Gidrodin.; No. 1, 106-10(Jan-Mar 1971). (In Russian).

Experimental investigation of the shunting effect shows that the head obtained as a result of a decrease in slip falls rapidly (calculations using various models yielded widely varying results). This may explain the presence of a transient resistance between the working substance and the walls; it varies the boundary conditions for the electric field on the surface of separation of the two media. The introduction of a concept of transient resistance frees the linearized theory of a transverse end effect, useful for a thin nonmagnetic gap, from some contradictory physical character. (tr-auth)

45336 EXCITATION FIELD OF LINEAR INDUCTION MACHINE WITH COUPLED WINDINGS ALONG LADDER NETWORK CIRCUIT. Kim, K. I.; Syucyukin, A. I.; Chemeris, V. T. Magn. Gidrodin.; No. 1, 111-19(Jan-Mar 1971). (In Russian).

A wiring diagram for the stator of a linear induction MHD machine is depicted, for which the current phase shift in the coil is produced by condensers between the coils and the busbars. After representing the windings in the form of a chain of T-form quadrupoles, the authors found the equivalent impedance of the coils and determined the parameters of these quadrupoles for an idealized no-load operation. The equations developed indicate that the influence of a pulsing field is felt in a redistribution of the inductive resistance and damping of the coils. After replacement of each quadrupole with an equivalent section of long line with distribution parameters — an inhomogeneous transmission line, and simulating an ideally distributed stator winding — the current distribution in the line was found, neglecting the damping for stability and absence of reflections from the end of the line. The calculated current distribution was used for deriving the magnetic induction in a magnet gap with alternating phase coefficient for the traveling wave of excitation current. (tr-auth)

45337 CURRENT COEFFICIENTS OF MHD DUCT OF CONDUCTION TYPE. Birzvalk, Yu. A. Magn. Gidrodin.; No. 1 120-6(Jan-Mar 1971). (In Russian).

Results from various authors for the potential distribution in a MHD converter duct are compared. A single form for representing the solution is suggested for the noninductive approximation. A comparison of the calculated results was made with the assumption that the field distribution along the longitudinal axis of the duct is characterized by the two parameters: relative pole excess and relative gap. (tr-auth)

Fluid Physics

45338 LONGITUDINAL EDGE EFFECTS IN LINEAR INDUCTION MAGNETOHYDRODYNAMIC MACHINE. Vol'dek, A. I.; Lazarenko, L. F. (Leningrad Polytechnic Inst.). Elektrichestvo; No. 11, 26-30(Nov 1970). (In Russian).

As a result of the finite length of linear induction MHD machines, electromagnetic fields in addition to the normal traveling electromagnetic wave occur. These fields increase the losses and decrease efficiency. In order to suppress these longitudinal edge effects, various compensatory windings on the machine are used. The effect of insulation membranes is also investigated. Equations are given for the total vector potential of the primary and secondary currents in various zones of the MHD machine. In the solution, one term gives the normal resulting field existing in an infinitely long machine, and two other terms are given for the edge-effect fields that produce damping waves. Expressions are given for suppression of edge effects in the active zone. (TTT)

45339 MAGNETOFLUIDMECHANIC PIPE FLOW IN A TRANSVERSE MAGNETIC FIELD. PART 2. HEAT TRANSFER. Gardner, R. A.; Lykoudis, P. S. (Purdue Univ., Lafayette, Ind.). J. Fluid Mech.; 48: 129-41(13 Jul 1971).

An experimental investigation was carried out of the influence of a transverse magnetic field on the heat transfer of a conducting fluid (mercury) flowing in an electrically insulated pipe subjected to a uniform heat flux at the wall. Mean temperature profiles and heat transfer data are presented which demonstrate that the magnetic field inhibits the convective mechanism of heat transfer through its damping of the turbulent velocity fluctuations. (auth) (UK)

45340 OPTIMIZATION PROBLEMS IN MAGNETOHYDRODYNAMIC FLOWS. Potter, William E.; Grossman, Lawrence M. (Univ. of California, Berkeley). Z. Angew. Math. Phys.; 22: No. 3, 552-63(25 May 1971).

The set of numbers C_i that maximize the power of the incompressible fluid generator with specified initial conditions and with finite segmentation was determined using the Bellman Principle of Optimality. It was found that the C_i are all given by the same constant. Also, the function C(x) that absolutely maximizes the power of the infinitely fine segmented generator is given by the same constant. Segmentation is of no advantage for an incompressible fluid generator when the magnetic induction is a given constant. The optimal initial conditions were determined for the generator when the initial conditions are constrained such that the stagnation enthalpy is a predetermined constant. The function C(x) that absolutely maximizes the power of the compressible fluid generator with specified initial conditions and with infinitely fine segmentation was determined. A limited number of other optimization problems in magnetohydrodynamic energy conversion was solved by the fundamental partial differential equation of dynamic programming. In particular, the optimal load can be determined in this manner for the infinitely fine segmented models of this paper if the magnetic induction is not a constant and $j = 1/\mu_0 dB/dx$ is a valid expression of this fact. The Bellman Principle of Optimality is the tool needed to solve many optimization problems involving finite segmented generators of magnetohydrodynamic energy conversion. Also, infinitely fine segmented generators can be efficiently approximated by employing the Bellman Principle of Optimality. In both cases there should be three or less state variables and a computer will most likely be needed. As demonstrated by these results for a compressible generator, the dependence between the individual segments can be an important aspect of magnetohydrodynamic energy conversion. (auth)

45341 VELOCITY DISTRIBUTION IN A PLASMA JET AT MHD DUCT OUTLET WITH A MAGNETIC QUADRUPOLE. Glazkova, P. I.; Grishin, S. D.; Denisov, Yu. N.; (and others). Magn. Gidrodin.; No. 1, 53-6(Jan-Mar 1971). (In Russian).

The topography of a magnetic quadrupole was considered, and the experimental velocity distribution in a jet of un-ionized argon at an MHD duct exit equipped with such a quadrupole. The velocity profile was obtained by measuring plasma velocity with a trap-calorimeter, and by measuring the directed velocity of neutral gas particles and ions by the Doppler shift of spectral lines. The data obtained on the variation of velocity distribution in the plasma jet at the duct exit in the presence of the magnetic quadrupole indicated the possibility of confinement of the plasma outlet from a scattered magnetic field with a smaller damping loss than in the case of ordinary distortion of magnetic and electric fields. In the magnetic quadrupole a plane, axial current symmetry was maintained in the jet issuing from the MHD duct. (tr-auth)

45342 LOCAL TWO-PARAMETER EQUATIONS FOR PLANAR MOTION OF A CONDUCTING INCOMPRESSIBLE FLUID IN THE MHD BOUNDARY LAYER. Borichich, Z. Magn. Gidrodin.; No. 1, 5-10(Jan-Mar 1971). (In Russian).

The basic equation for a plane, stationary, isothermal MHD boundary layer in an incompressible fluid with fixed conductivity in a transverse magnetic field leads to a universal form. The equation and boundary conditions in this case do not contain the characteristic quantities for each separate solution: electroconductivity, the velocity at the external boundaries, and the induction of the magnetic field. The universal equation obtained is solved in a two-parameter form with the following approximations: (1) localization of the effect of the magnetic parameter g_1 and (2) localization of the effect of the dynamic parameter f_1. The data obtained by calculation verify the already-known effect of the magnetic field on the characteristics of the boundary layer. A comparison of the results of integration of the two indicated, local equations show that their solutions for separate points of the plane (f_1, g_1) differ approximately by 12%. This circumstance points to the necessity of integrating the complete two-parameter equations. (tr-auth)

45343 THEORETICAL STUDY OF A THREE-DIMENSIONAL MHD FLOW IN A DIFFUSER. Shilova, E. I.; Shcherbinin, E. V. Magn. Gidrodin.; No. 1, 11-17(Jan-Mar 1971). (In Russian).

In connection with an experimental study by the authors of MHD flow in a diffuser, the problems were propounded concerning the flow of a conducting fluid between diverging walls and near one of the walls of a linear diffuser. It is shown that the first of these problems enters into a class of accurate solutions of the MHD equation, occurring in the Cartesian system of coordinates and constitutes a Hamel problem, the MHD aspects of

which have already been investigated. The second problem belongs to a class of accurate solutions with axial symmetry, which may be obtained in a cylindrical system. It was found that the phenomena experimentally observed are in satisfactory agreement with theory. (tr-auth)

45344 INFLUENCE OF A TRANSVERSE MAGNETIC FIELD ON TURBULENT VELOCITY PULSATIONS IN PIPES. Slyusarev, N. M. Magn. Gidrodin.; No. 1, 18-24(Jan-Mar 1971). (In Russian).

The results are given for an experimental investigation of the effect of a transverse magnetic field on the intensity of longitudinal and transverse velocity pulsations of mercury flow in straight and circular channels. The possibility of a conduction anemometer is considered. It is shown that the length of the portion of the stream in the field in which the pulsations are suppressed amounts to not less than 50 channel radii. The variation in the single-point correlation coefficient is evaluated, and an example is discussed. (tr-auth)

45345 INVESTIGATION OF CONDITIONS OF FORMATION OF M-FORM VELOCITY PROFILES DURING AN ABRUPT EXPANSION OR RESTRICTION OF THE MHD CURRENT. Gel'fgat, Yu. M.; Kit, L. G. Magn. Gidrodin.; No. 1, 25-30(Jan-Mar 1971). (In Russian).

On the basis of a qualitative examination of the MHD equation, the principles for the formation of M-form velocity profiles in the presence of a homogeneous magnetic field and the conditions for the formation of similar velocity structures are clarified. The results obtained were confirmed experimentally by means of a study of the potential gradient distribution over the portions of sudden expansion and contraction of a flow of mercury. It was established that M-shaped velocity profiles occur in those cases when, as a result of the electromagnetic power distribution in space, the electromagnetic force rotor is not equal to zero. (tr-auth)

45346 EXPERIMENTAL STUDY OF THE VELOCITY STRUCTURE OF MHD FLOW IN A RECTANGULAR CHANNEL WITH TWO CONDUCTING WALLS. Gel'fgat, Yu. M.; Dorofeev, V. S.; Shcherbinin, E. V. Magn. Gidrodin.; No. 1, 31-5(Jan-Mar 1971). (In Russian).

Experimental confirmation was obtained for the existence of a stable velocity structure with two sharply defined maxima in a rectangular duct with two conducting walls, perpendicular to the magnetic field, and two nonconductors. The results obtained agree satisfactorily with Hunt's theoretical solution. The part of such a velocity structure formed during passage of the current between magnetic poles was studied. (tr-auth)

45347 FLOW OF A PERFECTLY CONDUCTING COMPRESSIBLE FLUID PAST A THIN PROFILE IN THE PRESENCE OF A MAGNETIC FIELD. Putyata, V. I.; Sher'yazdanov, G. B. Magn. Gidrodin.; No. 1, 36-40(Jan-Mar 1971). (In Russian).

The flow of a conducting, nonviscous, compressible fluid around a thin profile in a magnetic field is considered. The equations are generalized for the case of random geometry. On the strength of linearity, the problem is divided into unsymmetrical and symmetrical parts. Within the region of parameters corresponding to hyper-elliptical flow, a solution is obtained in analytical form in all fields, dependent on Mach and magnetic Alfvén numbers. (tr-auth)

45348 EFFECT OF A CONSTRAINT ON FLOW AROUND CYLINDRICAL BODIES IN A TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Turuntaev, S. V.; Tsinober, A. B.; Shtern, P. G. Magn. Gidrodin.; No. 1, 41-8(Jan-Mar 1971). (In Russian).

On the basis of correlations of general hydrodynamics, a relationship was developed between Strouhal's number and the degree of constraint during current flow around cylindrical bodies. Experiment provided good agreement with theory. The effect of a transverse magnetic field on Strouhal's number was studied. On the basis of flow stability, experiments were conducted in order to account for the influence of a constraint in computations of dimensionless criteria for MHD flow around bodies. (tr-auth)

45349 PLANE JET OF CONDUCTING FLUID IN A COCURRENT FLOW. Zhivov, M. Z.; Sokovishin, Yu. A. Magn. Gidrodin.; No. 1, 49-52(Jan-Mar 1971). (In Russian).

The behavior of a plane, submerged jet of an incompressible conducting fluid was studied during diffusion in a homogeneous cocurrent stream in the presence of a magnetic field for an inductionless approximation. The solution of the partial differential equations showed that the jet decelerated asymptotically and that the initial profile had a satisfactorily small effect on the asymptotic values. (tr-auth)

45350 PROFILING OF THE EXTERNAL MAGNETIC FIELD DURING AN EVALUATION OF THE MHD DUCT EFFICIENCY. Kirillov, V. Kh.; Teplyakov, V. A. Magn. Gidrodin.; No. 1, 57-63(Jan-Mar 1971). (In Russian).

The three-dimensional problem of the electric field distribution is considered for an MHD duct of rectilinear cross section. The electrode zone possesses ultimate dimensions for which the magnetic field is constant. Beyond the limits of the electrode zone the electric field attenuates exponentially. The edge problem, which arises from this with composite boundary conditions, may be solved by a variant of the Wiener–Hopf approximation method. An electrostatic potential distribution is obtained for the MHD duct, and the integral characteristics are reduced to a function of the degree of decrease of the external magnetic field profile. (tr-autl.)

45351 EFFECT OF TRANSVERSE INHOMOGENEITIES ON GAS FLOW IN HALL-TYPE DUCT WITH SINGLE LOAD. El'kin, A. I.; Yantovskii, E. I. Magn. Gidrodin.; No. 1, 77-83(Jan-Mar 1971). (In Russian).

The gas flow in a single-loaded duct of the Hall type with graduated velocity distribution and temperature damping is examined. The conductivity is proportional to the 12th power of the temperature. The distribution parameters along the length and width of the duct and the volt–ampere characteristics are calculated, demonstrating the effects of the loading regime, the Hall parameters, and the mathematical exponent in the distribution law. Calculations from homogeneous and inhomogeneous currents are compared in order to evaluate the adaptability of the hypothesis concerning homogeneity. It is shown that the effect of inhomogeneity increases with an increase in the Hall parameter, an increase of the exponent in the distribution law, and with a fall in the loading current. At supersonic flow, the optimum temperature of the wall, producing a maximum value of the no-load voltage, may be significantly less than the average temperature of the stream. (tr-auth)

45352 ULTRASONIC VIBRATIONS OF A HORIZONTAL CYLINDER IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kiselev, M. I.; Kuksa, Yu. G.; Mikel'son, A. E.; Chernyi, Z. D. Magn. Gidrodin.; No. 1, 133-7(Jan-Mar 1971). (In Russian).

Theoretical calculations were made for a vibrating, conducting, fluid cylinder in crossed electric and magnetic fields, taking into account the magnetic viscosity of the working substance. A solution was obtained for the case when the pressure at the ends of the rod was equal to zero. Final results illustrated a dependency between various criteria that defined the process. The distribution of pressure about the axis of the cylinder was solved numerically. (tr-auth)

45353 EFFECT OF WALL CONDUCTIVITY ON VELOCITY PROFILE IN A CIRCULAR PIPE. Gnatyuk, V. V.; Paramonova, T. A. Magn. Gidrodin.; No. 1, 145-7(Jan-Mar 1971). (In Russian).

Flow velocities were measured in circular pipes with both conducting and nonconducting walls for specified Reynolds numbers and in the range of Hartman numbers $0 \leq H \leq 505$. The velocity profile was found for the flow in an insulated pipe for $H \gg 1$, with good agreement with the theoretical profile for laminar MHD flow. Considering flow in a copper tube near its wall, and in a direction perpendicular to the magnetic field, a region of increased velocity relative to the stream center was observed for $H \gg 1$. Flow in a circular pipe with conducting walls was also examined. (tr-auth)

45354 TRANSITION TO LAMINAR DRAG PRINCIPLES IN MHD FLOW BETWEEN ROTATING CYLINDERS. Shtern, A. G.; Shtern, P. G. Magn. Gidrodin.; No. 1, 148-9(Jan-Mar 1971). (In Russian).

Frictional forces were measured on circular plates placed between two rotating cylinders. With an increase in the magnetic field the coefficient of resistance approached a relationship defined by Covette laminar flow. For large Reynolds numbers, corresponding to turbulent flow, the transition occurs at Re/Ha ratios completely in agreement with literature data on rectilinear pipes. (tr-auth)

45355 COMPENSATING CURRENTS IN A NONUNIFORM MAGNETIC FIELD. Bol'shakov, V. B.; Korsunskii, L. M.; Sheiko, T. I. Magn. Gidrodin.; No. 1, 149-51(Jan-Mar 1971). (In Russian).

The end effect in electromagnetic flowmeters was studied. The effect of end currents on the sensitivity of measurement of flow rate was negligible. (tr-auth)

45356 EFFECT OF NONUNIFORMITY OF MAGNETIC FIELD AND VELOCITY PROFILE IN CONDUCTION FLOW-

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METER WITH DUCT OF RECTILINEAR CROSS SECTION FOR $Re_m \ll 1$. Gurevich, G. G.; Kirshtein, G. Kh. Magn. Gidrodin.; No. 1, 151-4(Jan-Mar 1971). (In Russian).

A convenient expression was developed for the voltage potential at MHD electrodes for arbitrary velocity profiles and magnetic field distributions along the duct. Calculated values are presented for electrode voltages corresponding to a series of geometric duct parameters in a step-wise distribution of the magnetic field along the longitudinal duct axis in laminar flow and flow at constant velocity along the cross section of the duct. (tr-auth)

Geophysics (Upper Atmosphere)

45357 (AD-717154) TRANSPORT AND LOSS PROCESSES FOR MAGNETOSPHERIC HELIUM. Report for June-August 1970. Cornwall, John M. (Aerospace Corp., El Segundo, Calif.). 14 Dec 1970. Contract F04701-70-C-0059. 18p. (SAMSO-TR-70-435). NTIS.

The anomalously low alpha/p flux ratio measured at $L \simeq 3$ can be understood qualitatively in terms of radial diffusion driven primarily by fluctuating electrostatic convection fields when proper account is taken of charge exchange and pitch-angle loss processes. It is shown that electrostatic radial diffusion seems to explain proton flux profiles better than magnetic diffusion for energies less than a few MeV. (auth) (USGRDR)

45358 (AD-717683) AREAL MAPPING: PRELIMINARY ASSESSMENT OF APPLICABILITY TO THE IONOSPHERE. Rush, Charles M.; Cookingham, Robert E. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 2 Dec 1970. 14p. (AFCRL-70-670; AFCRL-ERP-338). NTIS.

The mapping of ionospheric parameters for the purpose of extending and extrapolating observations is studied. It is found that a relatively simple contouring program can be used to specify the ionosphere in the lower regions that are under strict solar control. Using electron-density data representative of various ionospheric stations in North America, it is seen that the shape of the generated contours for the F region depend upon the location of the various stations. These results seem to imply the need for more sophisticated methods of synoptic representation of the upper-level ionosphere. (auth) (USGRDR)

45359 (AD-718376) ASYMMETRIC ACCESS OF ENERGETIC SOLAR PROTONS TO THE EARTH'S NORTH AND SOUTH POLAR CAPS. Van Allen, J. A.; Fennell, J. F.; Ness, N. F. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy. National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec 1970. Contract N00014-68-A-0196-0003. 40p. NTIS.

During the energetic solar-particle event that began on January 24, 1969, the ratio N/S of the intensity of protons $E_p > 0.3$ MeV over the Earth's north (N) polar cap ($\Lambda > 80$ degrees) to that over its south (S) polar cap ($-\Lambda > 80$ degrees) varied from a value greater than 20 to about 1, as observed with satellite Injun 5 in a low-altitude polar orbit. Observations by three different spacecraft are reported. The results are much clearer than earlier ones by virtue of the extraordinarily strong anisotropy of interplanetary particle intensity early in this event and the comprehensiveness of the observations. (auth) (USGRDR)

45360 (AD-718961) INFLUENCE OF GRAVITY WAVES ON TRANSIENT HEATING RESPONSE OF THE UPPER ATMOSPHERE. Report for August 1969-February 1970. Chiu, Yam T.; Ching, Barbara K. (Aerospace Corp., El Segundo, Calif.). 15 Dec 1970. Contract F04701-70-C-0059. 51p. (SAMSO-TR-71-21). NTIS.

It is shown that the presence of gravity-wave interaction with a transiently heated atmosphere changes the atmospheric response to heating significantly. The energy exchange between wave and ambient atmosphere manifests itself as an apparent increase in effective thermal diffusivity. The present model predicts altitude-independent (<200 km) temperature and density-time lags that are in phase and are 6 ± 2 hours for a mean heating duration of (2 to 6) hours. It is shown that the above response characteristics are essentially independent of the spatial distribution and location of the primary heat source. This tendency is a consequence of the increased heat diffusion due to energy exchange between wave and ambient atmosphere. The energy loss to gravity waves during the falling phase of the response leads to the prediction of a relaxation time of 15 ± 3 hours measured from the beginning of density decrease. The mean relaxation time for discernible major events in the Explorer-9 data is ~13 hours. (auth) (USGRDR)

45361 (AD-719876) IONOSPHERIC WINDS IN THE AURORAL ZONE. Rees, David (University Coll., London. Dept. of Physics). Oct 1970. Contract F61052-68-C-0057. 26p. (AFCRL-71-85). NTIS.

Observations of the drift velocity of rocket-borne chemical releases were used to determine neutral-wind velocity and ion velocity in the altitude range 90 to 230 km at ESRANGE, Kiruna. The ion cloud-drift measurements demonstrated the orthogonality of the simultaneous magnetic perturbation vector at ground level and the ion-drift vector in the F region of the ionosphere. This result implies that, in the auroral zone, Hall currents are predominantly responsible for that part of the total magnetic perturbation seen at ground level due to ionospheric currents. A comparison of neutral-wind velocity profiles obtained under quiet and disturbed geomagnetic conditions has shown that in the auroral zone the observed west-east neutral-wind component above about 120 km is directly correlated with the mean south-north magnetic perturbation vector over a period of two to three hours prior to the observations. This correlation is due to acceleration of the neutral atmosphere above 120 km by ions drifting in a meridional electric field. Both the ground magnetic perturbation and the neutral acceleration are direct functions of the locally enhanced electric field and of the electron (and hence ion) density. (auth) (USGRDR)

45362 (AD-720243) ION-ACOUSTIC WAVE INSTABILITY AT VLF IN THE POLAR WIND. Research Report, November 1969-July 1970. Koons, Harry C.; McPherson, Donald A.; Schulz, Michael (Aerospace Corp., El Segundo, Calif.). 30 Nov 1970. Contract F04701-70-C-0059. 45p. (SAMSO-TR-70-437). NTIS.

Calculations based on plasma kinetic theory reveal that ion-acoustic waves in the elf and vlf bands become unstable in the polar wind when the relative flow velocity between the hydrogen ions and oxygen ions enters the range 5 to 10 km/sec. Either of two distinct roots of the dispersion equation can exhibit growth, depending upon the relative composition of the plasma and the relative flow velocity. Electrostatic waves in the appropriate frequency range were observed at altitudes 2500 to 500 km over the polar regions by a vlf receiver on the OV3-3 satellite. These waves may be important in impeding the escape of polar-wind hydrogen and helium ions. (auth) (USGRDR)

45363 (AD-720247) NUMERICAL STUDY OF THE SEASONAL AND SOLAR CYCLE CHANGES OF THE MID-LATITUDE NEUTRAL AIR WINDS. Rush, Charles M.; Pustaver, John A. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 9 Dec 1970. 30p. (AFCRL-70-725; AFCRL-ERP-346). NTIS.

The coupled equations representing the horizontal neutral-air winds arising from the diurnal variation of atmospheric pressure are solved numerically. Taking full account of the diurnal and seasonal variation of electron density, meridional and zonal winds were computed at midlatitudes for both solar-maximum and solar-minimum conditions. The daily variation of both the meridional and zonal wind can be well represented by a daily mean plus a 24- and 12-hour oscillation, and tabular values of the winds for each season are given for the height of the F2 maximum and for every 100-km interval from 200 to 500 km. These values can be used to readily compute the associated vertical drift velocity at any middle-latitude location when account is taken of the local geomagnetic field. (auth) (USGRDR)

45364 ELECTRON CONTENT AND TOPSIDE PLASMA TEMPERATURE STUDIES AT LOW LATITUDES DURING A PERIOD FROM SUNSPOT MINIMUM TO SUNSPOT MAXIMUM. Walker, G. O. (Univ. of Hong Kong). J. Atmos. Terrest. Phys.; 33: No. 6, 1041-53(Jul 1971).

Total electron-content results are presented for the period September 1963-August 1968 for Hong Kong (latitude 22.2°N, dip 30°). Diurnal, seasonal, and long-term solar variations of content were determined. The "winter anomaly" only becomes apparent as the solar cycle advances to a maximum. The peak content increased by a factor of 2 and the minimum content by a factor of 4 as the sunspot number increased from 5 to 120. Using bottomside ionogram information corresponding variations were obtained of total equivalent and bottomside thickness, the average topside plasma temperature and the ratio of top to bottomside contents. From sunspot minimum to maximum no definite increase was observed of either the total equivalent thickness or plasma temperature. There was an apparent drop of 30% in the ratio of top to bottomside content over the same period. The integrated production rate showed a definite solar-activity dependence while the effective loss rate did not. A seasonal reversal of the effective loss rate was observed. Near sunspot minimum the loss rate was a maximum in winter while near sunspot maximum the maximum loss rate occurred in summer. (auth) (UK)

45365 MODE CONVERSION AND AURORAL EFFECTS OBSERVED ON A POLAR VLF PROPAGATION PATH. Westerlund, S.; Svennesson, J. (Kiruna Geophysical Observatory, Sweden). J. Atmos. Terrest. Phys.; 33: No. 7, 1079-97(Jul 1971).

Mode conversion effects on the vlf signal from NPM (23.4 kHz) received in Kiruna are discussed. The observations are interpreted in terms of the isotropic propagation model of Wait and Spies (1964). The propagation is well described by this model for daytime with $\beta = 0.5$ km^{-1} and h = 70 km and for nighttime with $\beta = 0.5$ km^{-1} and h slightly larger than 90 km. The difference between the sunrise and sunset mode interference is explained by a lower reflection height after sunset than before sunrise. The scatter in the data is referred to variations in the times of effective sunrise and sunset. Seasonal and solar-cycle variations are observed. Auroral activity affects the average propagation conditions in such a way that the effective reflection height decreases with increasing Kp. Particle precipitation in the auroral zone can cause strong mode conversion. (auth) (UK)

45366 PITCH DISTRIBUTION OF PROTONS PRECIPITATING FROM THE AURORAL RADIATION REGION IN THE RANGE OF HUNDREDS OF keV. Kovrazhkin, R. A. (Inst. of Space Research, Moscow). J. Atmos. Terrest. Phys.; 33: No. 7, 1099-1105(Jul 1971).

The results of measurements of protons of medium energies carried out on the "Cosmos 261" satellite using a scintillation detector with four differential energy ranges from 300 keV to 9 MeV are described. The pitch distributions of protons for different intervals of invariant latitudes Λ during magnetically quiet time periods at the end of the year 1968 in the northern hemisphere at the altitudes of 220 to 240 km are given. In the center of the outer belt ($L = 4 \pm 0.5$) a quasi-trapped component of protons of 300 to 450 keV with the maximum at the pitch-angle $\theta = 90°$ is mainly present. A widening of the proton pitch distribution with an increase of invariant latitude was observed. At high invariant latitudes ($\Lambda \geq 70.5°$) a complete isotropy of proton flux in the range $10° < \theta < 170°$ was observed. In all four regions of invariant latitudes the flux of particles moving upwards from the atmosphere was usually comparable in magnitude to the flux of precipitating particles. The energy distribution for precipitating and quasi-trapped protons during long, stable precipitation events is presented. It is shown that the spectrum of precipitating protons is harder than of quasi-trapped ones. At severe spikes of proton intensity occurring sometimes during midnight hours the energy spectrum of precipitating protons becomes softer. The proton intensity in such spikes reaches the values observed earlier in other experiments during breakup phase of aurora IBC I. (auth) (UK)

45367 DETERMINATION OF NOSE FREQUENCY OF NON-NOSE WHISTLERS. Dowden, R. L. (Univ. of Otago, Dunedin, N. Z.); Allcock, G. McK. J. Atmos. Terrest. Phys.; 33: No. 7, 1125-9(Jul 1971).

A method is described for determining nose frequency (f_n) and minimum group delay (t_n) from measurements of group delay at many frequencies along the observed whistler trace. It is primarily intended for the analysis of whistlers which do not reach the nose frequency, but the multipoint sampling may give improved accuracy for nose whistlers also, particularly if the traces are ill-defined. It is well suited to digital computation since only algebraic manipulations are involved. (auth) (UK)

45368 TOTAL ELECTRON CONTENT DURING THE GREAT MAGNETIC STORM OF MARCH 8, 1970. Arendt, P. R. (Army Electronics Command, Fort Monmouth, N. J.). Nature (London) Phys. Sci.; 231: No. 26, 197-8(28 1971).

Total ionospheric electron content data were obtained at Fort Monmouth from polarisation measurements of the ATS-3 satellite beacon at 137.35 MHz. The bottomside ionosphere was simultaneously explored by bottomside vertical sounding. The ionograms obtained were converted to true-height electron-density profiles. Curves of height variations for F-region plasma frequencies were also obtained. Comparisons are made with the storm magnetograph from Fredericksburg, Virginia. The total electron content during the storm showed much higher than average values, but dropped very fast after reaching its high maximum, and during this fast decrease an oscillatory variation was observed. The bottomside ionosphere was completely disturbed. The true-height variations of the plasma frequencies indicated a bottomside electron-density depletion while the total content was still increasing, and a topside depletion while the total content was decreasing fast during bottomside expansion and enhancement. These observations were in agreement with topside sounder observations, which indicate that during the initial phase of magnetic storms having a steep onset the topside ionosphere shows enhancement of ionisation above, and depletion below, a zone of unchanged ionisation; also that depletion is observed at all topside altitudes during the recovery phase. Possible mechanisms for F-region depletion are discussed. (UK)

45369 SCINTILLATION FADING OF SIGNALS IN THE SHF BAND. Skinner, N. J. (Univ. of Nairobi, Kenya); Kelleher, R. F.; Hacking, J. B.; Benson, C. W. Nature (London) Phys. Sci.; 232: No. 27, 19-21(5 Jul 1971).

Scintillation fading of amplitude up to 4 dB in carrier level was frequently observed at the Mount Longonot satellite telecommunication station, near Nairobi, in Sept. 1970. The present authors report similar fading at night during March to April 1971. Comparison with ionospheric data appears to indicate that the fading was due to irregularities in electron density in the F region, and the correlation between scintillation fading, backscatter, and pre-midnight spread F was extremely high, and that between scintillation and backscatter was almost perfect. It is concluded that the fading is imposed by irregularities at the same level as those responsible for spread-F echoes and direct backscatter at 300 to 400 km in the equatorial ionosphere, and on the downward path from the satellite. Scintillation fading has also been observed on vhf beacon signals from both orbiting and geostationary satellites. The present observations extend the upper frequency limit for which ionospheric scintillation has been observed by a factor of about 40. Most scintillation measurements in the shf band, using radio-star sources at angles of elevation of 5° or less, have been explained in terms of irregularities in atmospheric density at tropospheric levels. The observations reported appear to represent the first cases of scintillation fading due to F-region irregularities for frequencies in the shf band. (UK)

45370 RELATIONSHIP BETWEEN DAY-TO-DAY VARIABILITY OF Sq AND INTERPLANETARY PLASMA PARAMETERS. Kane, R. P. (Physical Research Lab., Ahmedabad, India). Nature (London) Phys. Sci.; 232: No. 27, 21-2(5 Jul 1971).

The diurnal range of the quiet-time geomagnetic field shows a large day-to-day variability, and the possible contributions of the magnetopause, neutral sheet, and ring currents to these variations have been calculated to give a total of about 10 gamma. It was also suggested that the day-to-day variability of Sq may be related to changes in this magnetospheric contribution due to the large day-to-day fluctuations in the solar-wind parameters that determine the strength of the currents. Such a relationship is investigated in the present communication. The ground-based data used were for the H component at the equatorial stations Trivandrum and the midlatitude stations Alibag, and in order to investigate the relationship with interplanetary parameters, data obtained during the IMP-1 period (Nov. 1963 to Feb. 1964) were used. The daily ranges at the above stations were correlated with solar-wind velocity, kinetic energy, interplanetary magnetic field and its components, and the standard deviation. The correlations are shown tabulated and are discussed. It is concluded that the variation of the total interplanetary magnetic field is partly responsible for the day-to-day variability of the Sq current systems. It is not clear whether this past relationship comes about through similar changes in the ionosphere or through a magnetospheric contribution, but a substantial contribution appears to come from the ionosphere. In order to estimate the magnetospheric contribution, a study of the simultaneous data from the magnetometer in the geosynchronous satellite ATS-1 should be very useful, since ionospheric effects would be negligible at the ATS-1 height, while magnetospheric effects, if any, would be prominent. (UK)

45371 CORRELATIONS BETWEEN THE EARTH'S GRAVITATIONAL AND MAGNETIC FIELDS: EFFECT OF ROTATION IN LATITUDE. Hide, R. (Meteorological Office, Bracknell, Eng.); Malin, S. R. C. Nature (London) Phys. Sci.; 232: No. 28, 31-3(12 Jul 1971).

Reference is made to Hide and Malin (Nature, 225: 605(1970) and Nature Phys. Sci., 230: 63(1971)) where the discovery of a high degree of correlation was reported between the gravitational potential (g) and the nondipole geomagnetic potential (B), when the latter is displaced in longitude. It was there suggested that the effect of a more general rotation of B relative to g should be considered in future work, and such an analysis is here presented. It is shown that the conclusion of Acharya (Nature, 228: 758(1970)), that the value of the correlation coefficient would not be affected by a rotation in latitude, made from purely mathematical considerations, is invalid. (UK)

45372 IONOSPHERIC EFFECTS OF THE 1968 SOLAR PROTON BURSTS. (ON THE BASIS OF OBSERVATIONS AT THE VOSTOK STATION). Struin, O. N.; Shirochkov, A. V. (Arctic and Antarctic Scientific Research Inst., Leningrad). Inform. Byull. Sov. Antarkt. Eksped.; No. 78, 54-61(1970). (In Russian).

Absorption phenomena due to solar-activity-induced proton bursts were studied on the basis of data collected during 1968 at the Vostok station. Its remoteness from the auroral zone makes it well suited to carry out such studies. It was found that absorption changes as a function of time agreed with the intensity variation of solar protons, as recorded by Explorer 34. The ionospheric scattering data were found to be more reliable than the usual short-wave absorption measurements during

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the polar night. Absorption at a frequency of 23.9 MHz under an inclined incidence was derived from cosmic-noise measurements. The data allowed correlation of the absorption at 30 MHz with the minimal reflection frequency, f_{min}, that depends on the sensitivity of the apparatus used and the deflecting absorption. It is desirable to derive an empirical relationship between f_{min} and absorption at a standard frequency of 30 MHz; an equation is proposed to this effect. (TTT)

45373 ANOMALOUS CASES IN THE PROPAGATION OF MEDIUM AND LONG RADIO WAVES AND PCA PHENOMENA ON THE BASIS OF OBSERVATIONS IN THE ANTARCTIC. Checha, V. A.; Gernandt, Kh. (Arctic and Antarctic Scientific Research Inst., Leningrad). Inform. Byull. Sov. Antarkt. Eksped.; No. 78, 74-80(1970). (In Russian).

Four cases of anomalous propagation of medium and long radio waves during periods of polar-cap absorption were investigated during the 13th Soviet Antarctic Expedition, using East-German geophysical data, in order to correlate solar and geophysical observations made during periods of the highest solar activity during 1968. It was found that the most strongly anomalous absorption occurred in the medium-wavelength range; it was especially strong at 540 kHz. The anomalous absorption phenomenon is very sensitive toward protons; it may start before the beginning and last after the termination of the corresponding polar-cap absorption (PCA). The area in which the phenomenon was observed was also larger than the usual PCA; this is due to the proton flux which is smaller than the flux causing PCA. Study of the propagation of medium waves may become a new tool for observing proton fluxes during the night. (TTT)

45374 OPERATING EXPERIENCE WITH A QUARTZ-FRAME DEVICE FOR MEASURING MAGNETIC VARIATIONS AT THE VOSTOK STATION. Shakhov, Yu. N. Inform. Byull. Sov. Antarkt. Eksped.; No. 78, 81-4(1970). (In Russian).

A three-component system was designed and built to record continuously the declination of the horizontal and vertical or northern and eastern components of the magnetic field. It contained a pickup system, variometer, recorders, and control system. The quartz sensing elements were located in leaktight nonmagnetic containers. The variation recording station was established at the inland Antarctic station Vostok during the 13th Soviet Antarctic Expedition in 1968 to record continuously the variations of the terrestrial magnetism near the geomagnetic pole. The temperature was not recorded continuously, therefore, a correction procedure must be used to evaluate the data. The device operated correctly for 2½ months. After further thermostating and other improvements, the system will be used for the qualitative variations of the terrestrial magnetic field. (TTT)

45375 ELECTROMAGNETIC RADIATION IN THE EARTH'S BOW SHOCK. Olson, John Virgil. Los Angeles; Univ. of California (1970). 276p. University Microfilms Order No. 71-16,347.

Thesis.

The spectrum, as detected by the UCLA–JPL Search Coil Magnetometer, extends from below the ion-cyclotron frequency to the electron-cyclotron frequency and is composed of two essentially different parts. Between the lowest measurable frequencies and at approximately 5 Hz the spectrum is dominated by large-amplitude wave trains that extend up and downstream from the shock compression. At frequencies above 5 Hz the spectral amplitudes decrease sharply with increasing frequency, exhibiting a f^{-3} to f^{-4} spectral dependence in the spacecraft frame. Both random fluctuations and short-lived packets of radiation are found in this frequency domain. The total energy density that the spectrum of electromagnetic fluctuations represents is approximately 10^{-11} ergs/cm^3. The spectrum varies by about an order of magnitude from crossing to crossing due to changes in the amplitudes and durations of the various spectral components. This energy density is approximately 1% of the total solar-wind energy density. The variations in the spectrum of waves, both spatial and temporal, is noted and evidence is presented to show there is little local time dependence of the electromagnetic-wave structure near the shock. Evidence is presented which indicates the broad spectrum of waves is apparently generated by electrons whose pitch-angle distribution is destabilized as they penetrate the shock compression. (TSS) (Diss. Abstr. Int., B)

45376 MEASUREMENT OF LOW-ENERGY PROTONS IN A PULSATING AURORA. Johnstone, Alan David. College, Alaska; Univ. of Alaska (1970). 132p. University Microfilms Order No. 71-15,062.

Thesis.

A Nike–Tomahawk rocket carrying particle detectors was launched into a display of pulsating aurora in the recovery phase of a large auroral substorm. The proton energy spectrum between 3 and 30 keV was measured in greater detail than had been achieved before, and it was found that the differential energy spectrum had the form AE^{-r} with r varying from 2.1 to 2.9. Above the atmosphere the pitch-angle distribution was flat, i.e., the greatest intensities were at pitch angles of 90°. Below an altitude of 200 km the protons were scattered considerably in collisions with atmospheric molecules. Below 160 km the pitch-angle distribution was essentially isotropic. There were time variations in the proton count rate too fast to be attributed to spatial variations in the proton flux, when spreading of the beam by charge-exchange cycling is taken into account. The variations correlate with changes in the electron flux such that the proton spectrum softens and the electron spectrum hardens during the event. The precipitated flux of both electrons and protons increases. (TSS) (Diss. Abstr. Int., B)

45377 DYNAMICS OF GEOMAGNETICALLY TRAPPED RADIATION. Roederer, J. G. Physics and Chemistry in Space. Volume 2. New York; Springer-Verlag New York Inc. (1970). 178p.

The dynamics of geomagnetically trapped particles reaches beyond geophysics now to include Jupiter's radiation belts, particle trapping in sunspot magnetic fields, cosmic rays confined in interstellar fields, and ultra-high-energy particles trapped in the magnetic fields of rotating neutron stars. This monograph is a complement to the existing literature on the basic dynamical processes that control the Earth's radiation belts. A thorough knowledge of adiabatic theory is necessary for carrying out experimental and theoretical research, and these are studied in depth. A study is presented on the violation of adiabatic invariants and trapped-particle diffusion. 50 references. (J.C.W.)

45378 PRODUCTION OF A MAGNETIC-FIELD-ALIGNED ELECTRIC FIELD BY THE INTERACTION BETWEEN THE HOT MAGNETOSPHERIC PLASMA AND THE COLD IONOSPHERE. Hultqvist, Bengt (Kiruna Geophysical Observatory, Sweden). Planet. Space Sci.; 19: No. 7, 749-59(Jul 1971).

The interpretation of recent observations of field-aligned ions with energies in the keV range in terms of an electric field parallel to the geomagnetic-field lines between the hot plasma from the plasma sheet, in its horns going to the atmosphere, and the cold ionospheric plasma is discussed. Some quantitative results, based on the assumption that some kind of diffusion dominates the propagation through the horns of the plasma sheet, show that magnetic-field-aligned electric fields may sometimes exist and that the total potential difference between the ionosphere and the plasma sheet may even exceed 10 kV. The effects on the voltage difference of the detailed shapes of electron density and equivalent temperature distributions between the ionosphere and the plasma sheet are discussed, as well as the dependence of the electric field on various other parameters. (auth) (UK)

45379 ENHANCEMENTS IN ELECTRON CONTENT AT ARECIBO DURING GEOMAGNETIC STORMS. Nelson, G. J.; Cogger, L. L. (Arecibo Observatory, Puerto Rico). Planet. Space Sci.; 19: No. 7, 761-75(Jul 1971).

A phenomenon was observed at Arecibo, Puerto Rico in which the total electron content of the ionosphere, in a column nearly parallel to the geomagnetic field, is enhanced in the afternoon or night during a magnetic disturbance. The enhancement is associated with the large negative excursion in the H component of the local geomagnetic field induced by the ring current. The enhancements which occur at night begin simultaneously with a downward motion of the F layer. This motion however is not a disturbance phenomenon as it is observed on 85% of all nights at Arecibo regardless of magnetic activity. The downward motion and the enhancement in electron content which accompanies it on disturbed nights commence later in local time at higher latitudes. Neither north–south nor east–west motions of ionization appear to be able to explain the nighttime enhancements unless in the latter case eastward winds with velocities greater than 500 m/sec exist. Diffusion of ionization from the protonosphere and direct ionization have also been excluded as possible mechanisms. (auth) (UK)

45380 WHISTLER-MODE ECHOES OBSERVED ON THE FR-1 SATELLITE. Diesendorf, M. O. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 19: No. 7, 739-47(Jul 1971).

A study was made of the magnetic-field intensities of 2-hop whistler-mode pulses transmitted at 16.8 kHz by FUB in France (L = 2.12, power = 20 kW) and received on the FR-1 satellite (altitude 750 to 770 km, inclination 76°) in the zone close to the transmitter. In general these 2-hop "echoes" tend to occur in a belt which is narrow in L and extends over the transmitter zone in an east–west (geomagnetic) direction for at least 30° longitude. For all but one of the 12 passes with echoes for which quantitative data is available, the intensities of the direct ground-to-satellite signal and echo are uncorrelated. While the intensity of the direct

signal received on FR-1 decreases rapidly with geomagnetic longitude separation from the transmitter, the echo intensity does not; further, the ratio $D(t)/E_s(t)$, where E_s is the power of the strongest echo pulse received on a given pass, and D the corresponding direct pulse power, ranged in value from 0.1 to 1600 over all passes. The observations suggest that the existence of echo regions is a consequence of focusing rather than of ducting. (auth) (UK)

45381 IONOSPHERIC WARMING BY NEUTRAL WINDS. Stubbe, P. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.); Chandra, S. Planet. Space Sci.; 19: No. 7, 731-7(Jul 1971).

The effect of frictional heating by means of neutral winds on the ion and electron temperature in the undisturbed ionosphere is studied theoretically by solving a system of basic ionospheric and atmospheric equations. The study shows that both the electron and ion temperatures are increased in the nighttime ionosphere through friction. In the region between 150 and 200 km T_i may exceed T_e by as much as 130°. The increase of T_i due to friction amounts to about 100 to 200°, depending on the atmospheric model employed in calculating the neutral-wind velocity. It is illustrated that frictional heating may be very important for the determination of the neutral temperature from measured ion-temperature values. (auth) (UK)

45382 IMPLICATIONS OF THE SEMI-ANNUAL VARIATIONS IN THE F2 REGION FOR THE LOWER THERMOSPHERE. Bhatnagar, V. P. (Univ., Bonn). Planet. Space Sci.; 19: No. 7, 723-9(Jul 1971).

The observed amplitude of the semiannual variation in the F2 region, like the one in the upper neutral atmosphere, can be used to estimate the ratios of the dissociation (O/O_2) of atomic oxygen density and of the temperature in equinoctial months to that in solstitial months in the lower thermosphere. The semiannual variation in the F2 region implies not only the semiannual variation in the temperature but also in the composition at the lower heights. Simple calculations based on the observed semiannual variation in the F2 region show that the semiannual variation in the temperature and in the dissociation exists in phase and out of phase respectively, with that in the atmospheric density, the electron density, and the height of the F2 peak for low solar activity. The maximum values for the dissociation, the atomic oxygen density and the temperature exceed their minimum values in the range of 10 to 30% at 120 km, which is in agreement with that deduced from the observed semiannual variation in the upper atmosphere by Bhatnagar (1970) for moderate latitudes during low solar activity. (auth) (UK)

45383 PERIOD STRUCTURE OF Pc3, 4 MICROPULSATIONS. Gupta, Jagdish C.; Stening, Robert J. (Earth Physics Branch, EMR, Ottawa). Planet. Space Sci.; 19: No. 7, 715-22(Jul 1971).

Several simultaneous rapid-run record intervals length of 1 to 2 hr taken from the records of four observatories in Canada were analyzed for Pc3 and Pc4 periods. Frequently several periods were found in one record interval, and different periods were seen at different stations during the same interval. Pc3 periods showed no preference for particular values but tended to be smaller at times of higher K_p. However, certain periods occurred more frequently in the Pc4 band and additional longer periods appeared at more magnetically active times. No consistent dependence of periods on latitude was found for either band. The Pc3 results fit a model where longitudinal HM waves are excited in a cavity in the upper atmosphere. On the other hand, Pc4 could be due to transverse HM waves excited at the plasmapause. These would propagate to the auroral region and thence to other latitudes through the ionosphere. (auth) (UK)

45384 POLAR SUBSTORM AND INTERPLANETARY MAGNETIC FIELD. Kokubun, Susumu (Tokyo Univ.). Planet. Space Sci.; 19: No. 7, 697-714(Jul 1971).

By means of the IMP-3 magnetic data, a study is made on the relationships between the interplanetary magnetic field and the development of polar substorm. It is found that an explosive growth of the westward electrojet tends to appear after the interplanetary magnetic field has directed southward for 1 to 2 hr. Examinations of ground magnetic data indicate that the magnetic variation of a twin vortex mode is enhanced with the southward changes of the interplanetary magnetic field in the pre-explosive phase of the westward electrojet. In the early stage of this phase sudden geomagnetic impulses are often observed in association with tangential discontinuities in the solar wind. An explosive appearance of auroral electrojet often corresponds to changes in direction and/or magnitude depression of the interplanetary magnetic field. Such a typical sequence is also found at the main-phase beginning of magnetic storms. It is suggested that the polar magnetic substorm is a two-stage phenomenon lasting 4 to 6 hr. The twin current vortices in the polar region develop with the southward interplanetary magnetic field during the pre-breakup phase of 1 to 2 hr duration. This is probably a manifestation of the energy storage process in the magnetotail. (auth) (UK)

45385 OBSERVATIONS ON PULSATING AURORAS. Miller, R. E.; Zeitz, W. M. (Xavier Univ., Cincinnati). Planet. Space Sci.; 19: No. 7, 693-6(Jul 1971).

Optical auroral pulsations in λ3914 N_2^+ and λ5577 O I were measured in the frequency range 0.01 to 1.0 Hz by a double photometer system during the NASA Airborne Auroral Expedition. The spectral density calculations invariably show a pronounced peak in the range 0.05 to 0.2 Hz. The pulsating forms were confined to the region between 62 and 69° North latitude. No pulsations were detectable in the λ4861 Hβ emission. (auth) (UK)

Low-Temperature Physics and Cryogenic Equipment

45386 PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CONFERENCE ON LOW-TEMPERATURE PHYSICS, ST. ANDREWS, SCOTLAND, AUGUST 21–28, 1968. VOLUME I. Allen, J. F.; Finlayson, D. M.; McCall, D. M. (eds.). St. Andrews, Scotland; Organising Committee, Eleventh International Conference on Low-Temperature Physics (1968). 711p. (CONF-680808–(Vol.1)).

The plenary papers are presented in this volume. Papers on helium 4, helium 3, and mixtures are included under the following subjects: adsorbed helium films; critical velocities and turbulence in helium II; critical velocities, superflow, and the helium-II film; helium II near the lambda transition; critical and other phenomena in helium 3 and helium 4; ions in rotating helium; ions and vortices in liquid helium; bubbles and excitations in liquid helium II; rotating liquid helium II; solid helium 3 and helium-3–helium-4 (mainly NMR); liquid helium-3–helium-4 mixtures; liquid helium-3 theory, liquid helium-4 excitations and microscopic theory; and solid helium 4 and helium-3–helium-4 mixtures. Subjects covered in experimental methods and other low temperature phenomena are: thermometry (general) and cerium magnesium nitrate, hyperfine interactions, dielectric crystals, Kapitza resistance, relaxation and thermal conductivity, hydrogen and deuterium, helium-3–helium-4, helium II (mainly refrigeration, and miscellaneous applications and phenomena). (M.H.R.)

45387 PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CONFERENCE ON LOW-TEMPERATURE PHYSICS, ST. ANDREWS, SCOTLAND, AUGUST 21–28, 1968. VOLUME II. Allen, J. F.; Finlayson, D. M.; McCall, D. M. (eds.). St. Andrews, Scotland; Organising Committee, Eleventh International Conference on Low-Temperature Physics (1968). 706p. (CONF-680808–(Vol.2)).

Papers included on superconductivity are grouped under the following headings: tunneling and the energy gap, Type-I superconductivity, fluctuations, domains, flux motion, flux pinning, pure niobium, vortices, films, etc., proximity effects, band structure, and the Kondo effect in superconductors. Papers on normal metals and magnetic ordering are grouped under: transport properties, helicons and Alfven waves, magnetism in rare-earth metals and alloys, Fermi surface studies (chiefly de Haas-van Alphen), magnetoresistance, many body theory, Fermi surface studies (rf and ultrasonics), Kondo effect, magnetism in transition metals and alloys, antiferromagnetism in salts, and miscellaneous properties of solids. (M.H.R.)

Superfluidity

45388 EVIDENCE OF METASTABLE ATOMIC AND MOLECULAR BUBBLE STATES IN ELECTRON-BOMBARDED SUPERFLUID LIQUID HELIUM. Hill, J. C.; Heybey, O.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Lett.; 26: No. 20, 1213-16(17 May 1971).

Infrared absorption spectra of electron-bombarded superfluid liquid helium established that: (a) $a^3\Sigma_u^+$ helium molecules and probably 2^3S_1 atoms are present in the liquid in concentrations of the order of $10^{13}/cm^3$ in an excitation volume ~0.05 cm^3, for a 1-μA bombarding beam of 160-keV electrons; (b) these states are metastable with lifetimes of the order of a millisecond at 1.7°K; (c) the $a^3\Sigma_u^+$ molecules are de-excited by $a^3\Sigma_u^+ - a^3\Sigma_u^+$ collisions in the liquid; and (d) the local configuration of the surrounding liquid helium is different for different excited states of the helium atomic and molecular systems, and the configurational interaction with the host fluid has an appreciable effect upon the electronic energies associated with these excited states. (auth)

45389 MEASUREMENT OF THE OSMOTIC PRESSURE OF ^{3}He IN SUPERFLUID ^{4}He. London, H. (Atomic Energy Re-

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search Establishment, Harwell, Eng.). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 95-9(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

An apparatus for measuring the osmotic pressure of ^{3}He in superfluid ^{4}He by comparing it with the fountain pressure of pure ^{4}He is described. It consists of a bulb provided with an electrical heater and a thermometer and connected by a capillary to the point at which the osmotic pressure is to be measured. A thermal contact is made at a point near the bulb between the capillary and a heat sink (0.6 to 0.9°K) such as the evaporator of a dilution refrigerator. The heat produced by the heater (10 to 20 μW) enables all of the ^{3}He present in the bulb and in the capillary between the bulb and the thermal contact to be driven out. Because of the high thermal conductivity of pure ^{4}He, this part of the capillary is at the same temperature as the bulb. Beyond the thermal contact, the presence of ^{3}He stops the heat flow. The sum of the osmotic and fountain pressure is constant in the whole system and, therefore, equal to the fountain pressure inside the bulb; the latter may be deduced from the indications of the thermometer. (France)

45390 BOILING HEAT TRANSFER TO LIQUID HELIUM IN INCLINED CHANNELS. Sato, S.; Ogata, H. (Hitachi, Ltd., Tokyo). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 119-23 (1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Heat transfer to boiling liquid helium in inclined channels with small diameters was studied in relation to the problem of stability with large-scale superconducting magnets. The channel length was 220 mm, and the gap inside the channel was either open or closed and with a diameter varying between 1 and 5 mm. Channel inclinations between the vertical and horizontal positions were investigated. Typical experimental results show the strong dependence of the critical heat flux upon the boiling length/equivalent diameter ratio and also upon the angle of inclination and the direction of the heated surface. The critical flux is assumed to depend on the volume of the bubbles in the channel. (France)

45391 HEAT TRANSFER TO LIQUID HELIUM IN SIMULATED CHANNELS OF SUPERCONDUCTING PANCAKE COIL. Yasukochi, K.; Kobayashi, H.; Nose, S. (Nihon Univ., Tokyo). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 133-7(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Measurements of the heat flux transferred from a metallic surface in the normal state to boiling helium in horizontal or vertical cooling channels were performed in connection with superconducting magnet stabilization. The cooling channel has a rectangular cross section with a gap width d. The two copper parts of a gage element are plugged into its inner wall, at one end of the tube, one facing the other. The configuration may simulate the appearance of the resistive transition on the inner layer of flat coils above the critical current. The maximum nucleate heat flux Q_n was measured as a function of d. Q_n increases when d decreases until the limiting values of 1 W/cm^2 for the upper surface and 0.2 W/cm^2 for the lower surface when d = 3 mm is reached. A change in the cooling of the lower surface by bubbles escaping from the upper hot surface is shown by increasing the convection and reducing the cooling efficiency. In the case of a vertical channel, Q_n is independent of d, provided that d remains greater than 0.05 mm; this is contrary to Wilson's results. The experimental results are used in discussing an optimized configuration for the stabilized superconducting magnets. (France)

Superconductivity

Refer also to abstracts 45176 and 45799.

45392 (AD-718415) INVESTIGATION OF THE SUPERCONDUCTING ENERGY-GAP BEHAVIOR OF SINGLE-CRYSTAL RHENIUM BY TUNNELING. Ochiai, Shin I.; MacVicar, Margaret L. A.; Rose, Robert M. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science). 3 Feb 1971. Contract N00014-67-A-0204-0041. 35p. (TR-5). NTIS.

A 15.7% anisotropy in the superconducting energy gap was measured by electron tunneling into single crystals of rhenium, using thin carbon films as the tunneling barrier to form Re/C/In sandwiches. The energy gap behavior with temperature is BCS-like. The anisotropy agrees with ultrasonic measurements of other hcp metals and suggests that phonon dispersion plays a dominating role in the gap behavior. However, gap values determined from multiparticle tunneling data exhibited reduced gap magnitudes, and a dissimilar crystallographic behavior. (auth) (USGRDR)

45393 (COO-1569-78) FLUCTUATIONS IN THE D.C. JOSEPHSON CURRENT. Goldman, A. M. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). [1970]. Contract AT(11-1)-1569. 19p. (CONF-710322-1). Dep. NTIS.

From Meeting of the American Physical Society; Cleveland, Ohio (29 Mar 1971).

The pair current is calculated completely within the framework of phenomenological theory using linear response techniques. The quasi-particle tunneling channel and any effects the quasi-particle channel may have on the pair channel are neglected. The magnetic-field and temperature dependence of the I-V characteristics of two tin/tin oxide/lead functions, at temperatures above and in the vicinity of the transition temperature of tin, were compared with the results of calculations. The I-V characteristics exhibit an excess current that has the resonant behavior of the pair-fluctuation current. As precautions were taken to minimize the possibility of structural defects, the quantitative discrepancies between experiment and theory are an indication that corrections to the mean-field semiclassical susceptibility are needed. (M.H.R.)

45394 SUPERCONDUCTING MAGNET OF INTERMEDIATE RESISTIVITY SUBSTRATE AND FILAMENTARY SUPERCONDUCTOR COMPOSITE. Atherton, D. L. (Ferranti-Packard Ltd., Toronto). Can. J. Phys.; 49: No. 12, 1693-4(15 Jun 1971).

This 3-kg superconducting magnet uses a composite conductor of twisted fine filamentary niobium-titanium in a copper alloy matrix with resistivity of 0.44×10^{-6} Ω cm at 10°K, about 50 times that of high conductivity copper. The coil operates repeatedly at short sample critical current without potting. (auth) (Canada)

45395 EFFECT OF PRESSURE ON LATTICE OSCILLATIONS AND ELECTRON-PHONON INTERACTION IN SUPERCONDUCTORS. Zavaritskii, N. V.; Itskevich, E. S.; Voronovskii, A. N. (Inst. of Physical Problems, Moscow. Inst. of Physics of High Pressures, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1408-17(Apr 1971). (In Russian).

The tunnel effect in lead, tin, and indium subjected to pressure is investigated. The pressure dependence of the gap width Δ_0 and of the frequencies of the phonon spectrum state density singularities ω_i is obtained for the three metals. It is found that the quantity $d \ln \omega_i/dP$ depends on ω_i, somewhat decreasing with increase of ω_i. The data obtained and also the amplitude measurements of the quantity dV/dI for lead are employed for determining the change due to pressure of function $g(\omega)$, which describes the electron-phonon interaction. In all metals studied it is found that decrease of the function $g(\omega)$ under pressure is primarily the result of variation of the lattice oscillation spectrum. The variation of Δ_0, T_c, $2\Delta_0/kT_c$, and electron state density near the Fermi surface induced by pressure can be derived on the basis of decrease of $g(\omega)$. (auth)

45396 MAGNETIC QUANTIZATION AND ABSORPTION OF ULTRASOUND IN SUPERCONDUCTORS IN THE INTERMEDIATE STATE. Galaiko, V. P.; Bezuglyi, E. V. (Physical-Tech. Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1471-82(Apr 1971). (In Russian).

The wave functions and electron excitation spectrum in normal layers in the intermediate state of superconductors are found by taking into account the coherent phase difference between superconducting regions, which compensates the increment of the magnetic field vector potential on transition through the normal layers. The quantum absorption coefficient for a longitudinal sound wave moving along normal layers perpendicular to the magnetic field is calculated. Absorption exhibits characteristic oscillations due to magnetic quantization of the normal excitations. The oscillations are periodically modulated with respect to frequency and amplitude. (auth)

45397 PLASMON MECHANISM OF SUPERCONDUCTIVITY IN DEGENERATE SEMICONDUCTORS AND SEMIMETALS. II. Pashitskii, E. A.; Chernousenko, V. M. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1483-99(Apr 1971). (In Russian).

Qualitative and quantitative analyses of the nonlinear integral equation for the "gap" in the superconductor quasiparticle spectrum are carried out within the framework of the "jelly" model in the weak and strong coupling approximations (at both absolute temperature $T = 0$ as well as at $T \neq 0$). Results of a numerical solution of the problem by an electronic computer (BESM-6) are presented. The results are used for ascertaining whether the "plasmon" mechanism previously proposed (in the first half of this investigation) for superconductivity in degenerate semiconductors and semimetals possessing two or more free carrier groups (conductivity electrons, holes) with strongly differing effective masses and

concentrations is possible. It is shown that for a sufficiently high concentration of the major ("light") current carriers ($N \sim 10^{21}$ cm^{-3}) and small crystal dielectric permeability ($\epsilon_\infty \sim 1$, but $\epsilon_0 \gg \epsilon_\infty$) quite high critical superconductivity transition temperatures ($T_c \sim 100°K$) should be attainable, in principle. (auth)

45398 WEAK COUPLING IN SUPERCONDUCTORS DUE TO IRRADIATION. Volkov, A. F. (Inst. of Radio Engineering and Electronics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1500-8(Apr 1971). (In Russian).

The possibility of locally reducing the order parameter f in superconductors by means of irradiation and of creating in this way a controllable Josephson element is studied theoretically. One-dimensional equations describing the system are derived on basis of the familiar time equations for f. The critical current I_c is calculated for various values of the wave intensity and size of region of action of the wave. The calculation is also applicable to S/N/S and S/S'/S systems near the S (or S') and N transition temperatures. It is shown that the de Gennes method for determining I_c is not always correct. (auth)

45399 EFFICIENCY OF THE EXCITON MECHANISM OF SUPERCONDUCTIVITY IN LAMELLAR COMPOUNDS WITH MOLECULES. Bulaevskii, L. N.; Kukharenko, Yu. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 4, 1518-24(Apr 1971). (In Russian).

The interaction is considered between electrons in lamellar compounds consisting of conducting layers of dichalcogenides and nonconducting molecular layers with van der Waals interaction between the molecules and with the dichalcogenide layers (compounds of the TaS_2 (pyridine) $\frac{1}{2}$ type). It is shown that in such systems the contribution of the exciton mechanism to effective attraction of the conductivity electrons is small compared to the phonon contribution and the superconductivity transition temperature is determined by the phonon mechanism. In lamellar compounds the exciton superconductivity mechanism may be efficient only if electrons of the nonconducting layers have a low (≈0.1 to 1 eV) energy due to delocalization (e.g. in a system consisting of alternating conducting and nonconducting layers). (auth)

45400 FREQUENCY DEPENDENCE OF THE ULTRASONIC ATTENUATION IN SUPERCONDUCTING NIOBIUM IN THE MIXED STATE. Kajimura, Koji (Electrotechnical Lab., Tokyo); Ikushima, Akira. J. Phys. Chem. Solids; 32: No. 7, 1617-25 (Jul 1971).

Attenuation of longitudinal ultrasonic waves was measured in the frequency range from 25 to 700 MHz in a single crystal of high-purity niobium. The ratio of the attenuation coefficients in the superconducting and normal states, α_s/α_n, was measured as a function of magnetic field, H, at various constant temperatures. For the magnetic field near the upper critical field, H_{c2}, the result was found to be composed of two parts: in the immediate vicinity of H_{c2}, the attenuation coefficient obeyed the relation $1 - (\alpha_s/\alpha_n) = A(H_{c2} - H)$; at a field rather below H_{c2}, the coefficient was described by $1 - (\alpha_s/\alpha_n) = C(H_{c2} - H)^{\frac{1}{2}}$, a relation of Maki's pure limit theory. The above linear dependence on H hardly seems to obtain a plausible explanation at present. The observed value of C varied rather steeply around the frequency corresponding to $ql \simeq 1$, where q is the impressed wave number. The dip of the attenuation just above the lower critical field was also investigated. The depth of the dip was found to depend on the frequency as well as temperature, and the frequency dependence could not be accounted for by the existing proposals. Besides the above-mentioned results, the superconducting energy gap at 0°K without magnetic field was found to be smaller for higher frequencies. (auth) (UK)

45401 SYNTHESIS OF LOW-TEMPERATURE PHASES BY THE CO-CONDENSATION OF THE ELEMENTS: A NEW SUPERCONDUCTING A15 COMPOUND, V_3Al. Hartsough, L. D.; Hammond, R. H. (Univ. of California, Berkeley). Solid State Commun.; 9: No. 12, 885-9(15 Jun 1971).

A method is described whereby intermetallic phases, which are not stable at high temperatures, may be formed using controlled vacuum evaporation of the elements. V_3Al with the A15 structure was formed on substrates held at temperatures in the range 350 to 450°C. For the as-deposited sample the lattice parameter was 0.483 nm and the superconducting critical temperature was 9.6°K. (auth) (UK)

45402 SUPERCURRENTS IN THE PROXIMITY EFFECT. Deutscher, G. (Faculte des Sciences, Orsay, France). Solid State Commun.; 9: No. 12, 891-4(15 Jun 1971).

The diamagnetic response of a normal metal N in good electrical contact with a superconductor S is discussed in the limit of small applied fields and zero frequency. It is shown that even at high temperatures, the electron–electron interaction in the normal metal has a strong influence on the screening current density at some distance of the S/N interface. (auth) (UK)

45403 MEISSNER EFFECT IN Ag AND Cu BACKED WITH SUPERCONDUCTING Pb. Vallette, C. (Faculte des Sciences, Orsay, France). Solid State Commun.; 9: No. 12, 895-7(15 Jun 1971).

The diamagnetic properties of silver and copper backed with a thick lead layer were studied as a function of their normal-state electrical resistivity and of the temperature. The agreement between the experimental results and theory is good, and allows for a determination of the electron–electron interaction, which is found to be weakly attractive both in silver and in copper. (auth) (UK)

45404 VARIATION OF T_c WITH LATTICE PARAMETER IN V_3X COMPOUNDS. Smith, T. F. (Univ. of California, San Diego, La Jolla). Solid State Commun.; 9: No. 12, 903-5(15 Jun 1971).

A comparison is made between the lattice parameter dependence of T_c, as determined directly from the application of hydrostatic pressure and by alloying, in the system $V_3Al_xGe_{1-x}$. (auth) (UK)

45405 COMPARISON OF CALCULATED AND MEASURED LOWER CRITICAL FIELD FOR SOME Nb-Ti ALLOYS. Lubell, M. S.; Kernohan, R. H. (Oak Ridge National Lab., Tenn.). J. Phys. Chem. Solids; 32: No. 7, 1531-9(Jul 1971).

An expression is obtained from the Maki theory [Physics 1: 21(1964); 1: 127(1964)] for $H_{c1}(0)$ in terms of three measurable material constants T_c, ρ_n, and $H'_{c2}(0)$. The calculations are compared to the measured H_{c1} vs. T extrapolated to T = 0 K for three vacuum annealed Nb–Ti alloys. Values of $H_{c1}(0)$ are also determined from the computation of Harden and Arp (Cryogenics, 3: 105(1963)). Both sets of calculated values differ greatly from the measured values showing that the Maki theory is not applicable for $\kappa_{GL} < 30$, and the computation of Harden and Arp is not valid at T = 0 K in disagreement with recent results of Echarri et al (Phil. Mag., 18: 1089(1968)). Analysis of data available in the literature supports the conclusions. Comparison of the magnetization data near T_c with the theory of Neumann and Tewordt [Z. Phys., 189: 55 (1966)] shows reasonable agreement. (auth) (UK)

45406 CONTRIBUTION OF THE ANOMALOUS TERM TO THE NONLINEAR ELECTRICAL CONDUCTIVITY OF SUPERCONDUCTING ALUMINUM FILMS. Kajimura, K.; Mikoshiba, N. (Electrotechnical Lab., Tokyo). Phys. Rev. Lett.; 26: No. 20, 1233-5(17 May 1971).

Experimental data on the nonlinear excess conductivity of Al films due to the fluctuation of the order parameter were analyzed by taking account of the Aslamazov–Larkin term and the anomalous term proposed by Maki and Thompson. The analysis shows clearly the existence of a large contribution from the Maki–Thompson term to the nonlinear excess conductivity. (auth)

45407 STABILITY OF HARD SUPERCONDUCTORS IN CHANGING MAGNETIC FIELD PLUS SUPERIMPOSED DIRECT MAGNETIC FIELD. Kaiho, K.; Koyama, K.; Todoriki, I. (Electrotechnical Lab., Tokyo). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 155-61(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Experimental results from research into the stability of superconducting magnets in a changing magnetic field are presented. The behavior of dc in a superconducting closed loop was studied in the presence of an alternating magnetic field at fixed frequency of 50 c/s, and a constant magnetic field. The amplitude of the alternating magnetic field was varied between 0 and 3.5 kG and that of the direct magnetic field between 0 and 10 kG. The samples were Nb–Ti wires (0.27-mm diameter) with copper cladding (0.14-mm thick). Under ideal cooling conditions, the dc decreases until a constant value depending on the applied magnetic field is reached; then it stabilizes and remains constant. The equations relating the stable dc to the applied magnetic fields were obtained using the Bean model for the magnetic field distribution in the superconductor. The measured values are consistent with the equations. In consequence, the dc circulating inside the superconductor in the presence of a changing magnetic field may be predicted from the known magnetic characteristics of the superconductor. (France)

45408 FLUX JUMPS AND CURRENT DEGRADATIONS IN SUPERCONDUCTING Nb-50 PERCENT Ti SOLENOIDS. Chikaba, J.; Irie, F.; Yamafuji, K. (Kyushu Univ., Fukuoka). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 163-7(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Current degradation in superconducting coils is known to be closely related to sharp changes in flux or flux jumps. Since the possibility of flux jumps depends essentially on the balance of heat production and transfer from the sample to the liquid helium, the mechanism of flux jumps differs fundamentally in a coil and in a wire. In order to understand the mechanism of

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flux jumps in coils, systematic measurements of flux changes and sample heating were performed by varying both the heat transfer and the number of layers in the coils. The sample used was Formal-insulated Nb–50 Ti wire (0.025-cm diameter). The dimensions of the coils were as follows: 1.0-cm inner diameter, 1.06 outer diameter at 1.7 cm, and 2.5-cm length. Two different methods of measurement were used: the sample was either immersed in liquid helium or thermally insulated from the liquid helium bath. The transport current was then increased at a constant rate by a motor, and the induced voltage across the solenoid and the temperature change of the coil were measured. The experimental results enable a discussion of the mechanism of flux jumps and current degradation in coils. (France)

45409 MAGNETIC INSTABILITIES IN SUPERCONDUCTING MATERIALS. COMPARISON OF THEORIES AND PRACTICAL CONCLUSIONS. Lange, F.; Verges, P. (German Academy of Sciences, Dresden). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 169-71(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

The problem of the stability of superconducting materials against flux depends, according to the approach, either on the specific heat or on the thermal conductivity of the superconducting material. The temperature dependence of the stability of Nb–Ti wires against flux jumps was tested by coil simulation. The specific heat is shown to play the essential role in the problem. (France)

45410 EFFECT OF HEAT TREATMENT ON SUPERCONDUCTING PROPERTIES OF NIOBIUM–TITANIUM ALLOYS. Suzuki, T.; Furuto, Y. (Furukawa Electric Co., Ltd, Tokyo). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 173-9(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

The effect of heat treatment, cold working, and the critical current density on the mechanical properties of Nb–Ti alloys was studied. In addition to the conventional heat treatment, the effect of a two-step heat treatment yielding more effective precipitates was studied. The first step consists of aging for a long time at a given temperature and the second step of aging for a short time at an elevated temperature. Cold reduction has an important effect on critical current density, electrical resistivity and mechanical properties (hardness and yield strength). A two-step treatment very significantly increases the critical current density. Results are explained in terms of the fundamental concepts of nucleation and growth of precipitates. (France)

45411 SUPERCONDUCTING PROPERTIES OF V_3Ga TAPES AND SOLENOIDS. Fukuda, S. (National Research Inst. for Metals, Tokyo); Tachikawa, K.; Tanaka, Y.; Iwasa, Y.; Park, C. F. Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 181-5(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Superconducting V_3Ga tapes were made by the following process: the electroplating of gallium-coated vanadium tapes with copper and the subsequent heat treatment at about 650 to 700°C. The resulting V_3Ga tapes were then again plated with copper for stabilization and insulated with thin Mylar tapes. V_3Ga tapes 0.1 mm × 10 mm were wound into 25-mm-inner-diameter and 38-mm-outer-diameter pancake-shaped solenoids. The critical currents for the samples were measured at 4.2°K in constant magnetic fields up to 200 kOe for tapes and 150 kOe for coils. For magnetic fields of 150 to 200 kOe, the current-carrying capacity of V_3Ga is higher than that of Nb_3Sn. The critical currents in V_3Ga coils are about 200 A at 150 kOe. No degradation of this critical current due to winding was observed. The structural defects of V_3Ga were studied by transmission electron microscopy. Specimens were prepared using V_3Ga tapes with thinner substrates, pure or containing Zr traces. The only defects observed were grain boundaries. The critical current density strongly depends on grain size. In V_3Ga tapes containing Zr, the grain size is smaller and much higher current densities may be obtained. (France)

45412 TEMPERATURE DEPENDENCE (1.4 to 4.2°K) OF LOW FREQUENCY ELECTROMAGNETIC LOSSES IN NEUTRON-IRRADIATED Nb. Sekula, S. T. (Oak Ridge National Lab., Tenn.). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 191-6 (1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Single Nb crystals (resistivity ratio $\Gamma = 5000$) were irradiated at 40°C in the Oak Ridge Research Reactor with fast neutron flux up to 6×10^{19} n/cm^2 (E > 1 MeV). The effects of the defects created by fast-neutron irradiation on the low-frequency (350-Hz) electromagnetic response of Nb were investigated between 1.4 and 4.2°K using a Hartshorn bridge. The sample is placed in a dc field, superimposed on a sinusoidally varying field that may reach 400 Oe. A synchronous detector connected to the bridge output enables the measurement of the signal component proportional to magnetic losses occurring above H_{c1} until the normal state is made. When the neutron flux increases, the flux pinning due to radiation defects leads to a decrease in the losses in the intermediate state. On the contrary, above H_{c2}, the losses increase with the dose, owing to the increased resistivity of the normal state. A quantitative evaluation is given for the heat dissipation in irradiated niobium under various experimental conditions. The wave shape observed in the intermediate state shows that the Bean–London model is approximately correct and that it successfully predicts the critical current density $J_c(H)$. (France)

45413 AC LOSSES OF Nb–Ti WIRES AS FUNCTION OF WIRE DIAMETER. Nakayama, Y.; Horigami, O.; Koike, Y.; Saito, U. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 197-202(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Superconducting Nb–Ti wires were examined in order to ascertain that the ac losses occurring in fine filaments are small. The sample diameters were reduced by chemical etching, thus avoiding work-hardening effects. The I–V ac characteristics of a Nb–Ti wire (50–50 at. %), in the intermediate state were measured at 4.2°K and the ac losses were deduced from the data. Experimental results show that the ac loss per unit area, as a function of the surface field, does not depend on the sample diameter, within the limits of experimental error, for a diameter varying between 0.48 and 0.08 mm. The results are summarized by the following empirical equation $W_s = 3.7 \times 10^{-5} H_p^{3.45}$, where W_s is in Joule/cycle cm^2 and H_p in kOe consequently, a fine superconducting multifilament wire has a smaller ac loss than a single-core wire of the same cross section as the sum of the cross sections of the fine multifilaments, provided no interaction occurs between filaments. (France)

45414 NONLINEAR MICROWAVE PROPERTIES OF SUPERCONDUCTING THIN FILMS IN THE MIXED STATE. Gubankov, V. N.; Likharev, K. K. (Inst. of Radio Engineering and Electronics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 99-103(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 125-30(Jan 1971).

The reason for the appearance of nonlinear phenomena in superconducting thin films in the microwave region is discussed. The nonlinear phenomena are explained using a fluxoid model, in which the nonlinear effects arise from periodic motion of fluxoids in the film with their axes perpendicular to the film plane. The nonlinear effects are analyzed, taking account of the heating of the film and the irreversible character of fluxoid motion. Qualitative agreement between theoretical conclusions and the experimental results is found. (auth)

45415 SUPERCONDUCTIVITY AND LONG RANGE ORDER. Rickayzen, G. (Kent Univ., Canterbury, Eng.). Essays Phys.; 3: 1-34(1971).

An analogy is drawn between the order in superconductors and ferromagnets. It is shown that there is a molecular field theory of superconductivity analogous to the molecular field explanation of ferromagnetism. The evidence that now exists for the order believed to obtain in superconductors is discussed, and the limitations imposed on the molecular field theory by fluctuations are considered. (UK)

45416 SUPERCONDUCTIVITY AND STRUCTURE IN BETA-TUNGSTEN COMPOUNDS: SUPERCONDUCTING PROPERTIES OF INTERMEDIATE PHASES. Penfold, D. W. London; Imperial Coll. of Science and Tech. (1971). 283p.

Thesis.

The properties of the β–W phases of the four systems, Nb–Sn, V–Si, V–Ga and Nb–Al, were investigated as functions of composition. Apparatus is described that was used to measure the structural properties, lattice parameter, and ordering, as functions of temperature and to investigate a structural instability at low temperatures, all by x-ray powder methods. The measurement of superconducting critical temperatures is also described. A model is developed to interpret x-ray intensity data in terms of the atomic disorder in a nonstoichiometric alloy. This model is general for any binary alloy with two types of atom sites. The results obtained are: (1) A first-order structural transformation, to a martensitic phase, occurs in Nb–Sn and V–Ga but not in V–Si and Nb–Al. The transformation temperature is a function of lattice parameter, a sensitive indicator of composition. (2) The axial ratio of the martensite is a function of lattice parameter, and is of opposite sign on opposite sides of stoichiometry. (3) Superconducting critical temperatures are functions of lattice parameter. (4) The

disorder in nonstoichiometric alloys is predominantly by substitution and not by the creation of vacancies. (5) No classical order-disorder transformation takes place, all changes in order being attributable to changes of composition during heat treatment. The relationships between the structural and superconducting properties and the composition are explained on the basis of the hydrostatic strain in the lattice arising from the effects of atomic size in the nonstoichiometric alloys. (auth) (UK)

45417 MORE SOFT SUPERCONDUCTORS: ZrV_2 AND HfV_2. Lawson, A. C. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 36A: No. 1, 8-10(2 Aug 1971).

The temperature dependence of the electrical resistivity of ZrV_2 and HfV_2 shows evidence of lattice instability in these high-T_c superconductors. (auth)

45418 RIGHI-LEDUC EFFECT IN THE MIXED STATE OF A DIRTY TYPE-II SUPERCONDUCTOR. Tang, I-ming. Phys. Lett.; 36A: No. 1, 13-14(2 Aug 1971).

An expression for the Righi–Leduc effect is obtained which can qualitatively explain the recently reported measurements of the effect in the mixed state of Pb–In superconductive alloys. (auth)

45419 RESISTIVE TRANSITION OF SUPERCONDUCTING LAYER COMPOUNDS. Little, W. A. (Stanford Univ., Calif.). Phys. Lett.; 36A: No. 1, 17-18(2 Aug 1971).

It is shown that, in superconducting intercalated layer compounds, two resistive transitions should occur. One transition is associated with ordering in the planes and the other with ordering between the planes. The location of the second transition is shown to be determined by the size of crystallites in the sample. (auth)

45420 CONTROLLED FABRICATION OF Nb SUPERCONDUCTIVE TUNNEL JUNCTIONS WITH ANOMALOUS NEGATIVE RESISTANCE. Nordman, J. E.; Keller, W. H. (Univ. of Wisconsin, Madison). Phys. Lett.; 36A: No. 1, 52-3(2 Aug 1971).

An anomalous negative resistance seen occasionally in Nb-based superconductive tunnel junctions can be produced consistently on rf-sputtered Nb by backsputtering from the Nb surface before oxidation. The maximum current is larger than that for normal metal tunneling. (auth)

45421 CONGRES INTERNATIONAL SUR LES COUCHES MINCES. (International Congress on Thin Films). Conference Held in Cannes, France, October 5–10, 1970. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). 664p. (In French and English). (CONF-701032).

Ninety-eight papers were presented concerning the structure of sputtered films, the preparation of thin films, the measurement of thin film thickness, the superconducting and optical properties of thin films. Ten of them were abstracted separately for inclusion in NSA. (France)

For abstracts of individual papers see: 44716, 44717, 45422–45428, and 45602.

45422 PREPARATION OF THIN NIOBIUM FILMS IN AN ULTRAHIGH VACUUM APPARATUS EVACUATED BY A LIQUID-HELIUM CRYOPUMP. Boissin, J. C.; Cardinne, P.; Manhes, B. (L'Air Liquide, Sassenage, France). pp 141-6 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

In order to obtain niobium films with critical temperatures in the 9°K range, it is necessary to reduce the partial oxygen pressure during the deposition. A liquid-helium cryopump was chosen, which operated at 25°K because of its high pumping speed. Advantage was taken of the strong gettering effect of niobium, which was pre-evaporated over a large area of the chamber. The niobium was evaporated under a vacuum of 10^{-8} torr onto quartz substrates at 460°C. Superconducting films with critical temperatures similar to that of bulk niobium were obtained when the film thickness exceeded some critical value. The critical temperature was related to the evaporation rate. (auth) (France)

45423 TRANSPORT PROPERTIES OF GRANULAR SUPERCONDUCTORS. Cohen, R. W. (Radio Corp. of America, Princeton, N. J.). pp 233-43 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

The transport properties of granular superconductors in the normal and superconducting states are discussed in terms of a simple equivalence principle between transport by tunneling and by impurity scattering. Particular attention is given to the concept of an electronic mean free path in the electrical resistivity and the critical field. (auth) (France)

45424 ENHANCED SUPERCONDUCTING TRANSITION TEMPERATURES IN THIN FILMS. Watton, R. (Royal Radar Establishment, Malvern, Eng.). pp 257-66 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

An increase in transition temperature was observed in superconductors of small dimensions (~100 Å). The specific resistance at the transition temperature was measured for quenched indium, tin, and aluminum. The specific resistance is inversely proportional to the average bulk of the grains. It is possible to deduce from these results a formula explaining the variation in the enhanced transition temperature due to the surface phonons propagated in the grain boundaries. This analysis is extended to published data on the transition temperatures of very thin aluminum films. (auth) (France)

45425 EFFECT OF CHARGING AND OXIDATION ON NORMAL ELECTRIC CONDUCTIVITY AND SUPERCONDUCTIVITY OF THIN FILMS. Ruehl, W. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 309-21 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

An explanation of the electrostatic charge effect is given, and the idea extended to the case of superconductors. Results obtained using the classical capacitor method are discussed. The mechanisms involved in the oxidation of thin films at low temperatures are discussed, and the effect of this oxidation on the transition temperature is described. A tentative explanation using the BCS formula is given. Applications of the field effect produced are discussed. Surface and interface phenomena involving changes in electron density in superconductors are investigated. (auth) (France)

45426 PREPARATION, CRYSTAL STRUCTURE, AND SUPERCONDUCTING PROPERTIES OF THIN SPUTTERED FILMS OF THE TERNARY COMPOUND $Nb_3(Al–Ge)$. Octor, H.; Rocher, Y. A.; Renard, J. C. (ALCATEL, Bruyeres-le-Chatel, France. Compagnie Generale d'Electricite, Marcoussis, France). pp 399-408 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

Data are presented on the structure, the transition temperature, and the critical current densities of Nb–Al–Ge compounds with the A15 structure. The samples were prepared by a triode-sputtering technique and heat treated. For compositions similar to $Nb_{0.79}(Al_{0.73}Ge_{0.27})_{0.21}$, $T_c \simeq 14$°K and J_c ($H \leq 15$ kOe) $\simeq 10^6$ A/cm^2 values were obtained by low-temperature annealing (750°C for a few hours). The difference between this value of T_c and the value obtained for bulk samples ($T_c \simeq 20$°K) is discussed. (auth) (France)

45427 SURFACE RESISTANCE AT 3 GHz OF SUPERCONDUCTING Pb-Bi ALLOYS. Flecher, P. (Kernforschungszentrum, Karlsruhe, Ger.). pp 643-8 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

In view of particle accelerator applications, the rf surface resistance of lead as function of the mean free path was investigated at low temperatures. It is shown that a reduction of the mean free path can, in contrast to normal conduction, reduce the surface resistance of a superconductor in the Meissner state. All measurements were carried out with evaporated lead–bismuth layers. They were prepared in an ultrahigh vacuum system based on a new concept. This system, with a volume of about half a cubic meter and a minimum pressure less than 10^{-11} torr, allows evaporation at about 10^{-10} torr. (auth) (France)

45428 PREPARATION AND SUPERCONDUCTING PROPERTIES OF TITANIUM–VANADIUM THIN FILMS. Spitzer, H. J. pp 649-55 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

The superconducting properties of Ti–V thin films were studied. The alloys were deposited by simultaneously sputtering from two

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separate targets. After deposition, most of the samples were annealed for up to 3 hours at 700°C and cooled down quickly by switching off the substrate heater. The $J_c - H$ characteristics were determined and the transition temperatures measured. The superconducting properties of the Ti–V films prepared are superior to results reported to date. The current-carrying capacity is one-half to one order of magnitude higher, and transition temperatures are up to 3°K higher with a prominent maximum at the V-rich side of the system. (auth) (France)

Equipment and Devices

45429 (UCRL-Trans-1437) MEASURING THE Q OF SUPERCONDUCTING RESONATORS WITH A TRAVELING-WAVE TUBE. Zykov, A. I.; Knyazev, B. R.; Kheifets, M. I.; Kuznetsov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from report KHFTI-70-30. 19p. Dep. NTIS.

A method is described for measuring the loaded and natural Q of resonators. A uhf-power modulator circuit and connections are given. A method is proposed for measuring the uhf-oscillation damping decrement accurately to within 1%. Formulae are given for calculating the natural Q of re-entrant resonators. Results are reported of measurements of the Q of resonators with a superconducting coating of lead applied by cathode sputtering. (auth)

45430 NEW FABRICATION OF SUPERCONDUCTING FLUX DETECTOR. Goodkind, J. M.; Dundon, Jeffrey M. (Univ. of California, San Diego, La Jolla). Rev. Sci. Instrum.; 42: No. 8, 1264-5(Aug 1971).

A method for fabricating thin-film, weak-link superconducting niobium flux detectors is described. The niobium films are sputtered and subsequently anodized until the entire film behaves as if it were a weak link. (W.H.K.)

45431 CRYOPHYSICS AND CRYOENGINEERING. Meeting of Commission I of the International Institute of Refrigeration, Tokyo, Japan, September 11–12, 1970. Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 1-266(1970). (In French and English). (CONF-700964).

Forty-one papers were presented. They were grouped under the five following sections: measurement of temperature, ^{3}He–^{4}He refrigeration, heat transfer to liquid helium, superconductivity, and experimental techniques. Separate abstracts were prepared for nineteen of the papers. (France)

45432 POWERFUL DILUTION REFRIGERATOR. Berglund, P. M.; Ehnholm, G. J.; Gylling, R. G.; Lounasmaa, O. V.; Sovik, R. P. (Helsinki Univ. of Tech., Otaniemi, Finland). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 49-55(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

A ^{3}He–^{4}He dilution refrigerator, used as a precooling stage for nuclear demagnetization measurements, is described. The cooling powers obtained for a continuously operating machine with a maximum gas flow rate of 2.10^{-4} mole/s are, respectively: 10 erg/s at 15 mK; 26 erg/s at 20 mK; 80 erg/s at 30 mK; 155 erg/s at 40 mK. The final temperature that may be reached in the absence of any external heat contribution is 11 mK. When the system is used as a refrigerator without fluid recycling, the temperature of the mixer reaches 7 mK. Many technical characteristics of this refrigerator, related to the more general problems of research and development in the thermal exchanger and mixer field, are given. Thermometry and heat-transfer problems are also treated. (France)

For abstracts of individual papers see: 45389–45391, 45407–45413, and 45432–45440.

45433 NUMERICAL ANALYSIS OF CONTINUOUS AND DISCRETE HEAT EXCHANGERS FOR DILUTION REFRIGERATORS. Radebaugh, R.; Siegwarth, J. D. (National Bureau of Standards, Boulder, Colo.). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 57-62(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

The heat exchangers for dilution refrigerators have been constructed up until the present day with little quantitative data with regard to their operation. The results of numerical analysis of continuous and discrete heat exchanger operation are given. The thermal conduction existing in the concentrated and diluted flows is taken into account; in consequence, the determination of the temperature distribution implied the simultaneous solution of two differential equations of the second order for each type of exchanger. In the case of the discrete heat exchangers required for obtaining temperatures below 0.05°Kr, the fairly high thermal conductivity of liquids has an important effect on temperature distribution. In fact, with conventional dimensions, the liquid temperature is nearly constant in the whole body of the exchanger and the temperature change associated with each flow occurs essentially in the inlet fluid pipes, just before the exchanger inlet. Consequently, the impedance may be reduced (shorter tubes and larger diameters) without having significant effects on the thermal behavior of the exchanger. Diagrams enable the optimization of the dimensions of a given exchanger leading to a rapid obtainment of the equilibrium and a temperature as low as possible. (France)

45434 DILUTION REFRIGERATOR FOR NUCLEAR BOILING DESIGNED TO MINIMIZE EDDY-CURRENT HEATING. Ohtsubo, A.; Satoh, T.; Terui, G.; Inoue, M.; Kanda, E. (Tohoku Univ., Sendai). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 63-6 (1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Two simple methods for measuring the anomalous nuclear magnetic resonance of fine metallic particles at very low temperatures and in the presence of a very weak magnetic field are proposed. Both methods combine dilution refrigerator principles and a nuclear demagnetization. The first method involves a spin-alone cooling in the continuously operating mixing chamber and the demagnetization of the nuclear stage in a very low NMR field under truly adiabatic conditions. The second method involves lattice cooling. In this case the mixing chamber, including the nuclear sample powder, must be thermally insulated during and after demagnetization. For NMR experiments, in very low fields (10^2Oe), a fine indium powder is used, either as a nuclear thermal shielding or mixed with the sample to obtain a thermal bath for τ_1 measurements. In both methods, the demagnetization is so fast (10^1 and 10^3 s, respectively) that the heat release due to eddy currents would be large if a conventional heat exchanger made of hot sintered copper were used. Consequently, heat exchangers consisting of concentric thin-walled tubes at high temperatures and exchanging discs made of a sintered alloy at low temperatures, when the Kapitza resistance plays a leading role, are used. When the dilution refrigerator consists of exchanger discs made of sintered brass, a change in the magnetic field from 8000 Oe (3200 Oe for the lower disc) to zero in 40 s corresponds to a neglible increase in temperature in the mixing chamber (at 0.18 K). (France)

45435 ^{3}He–^{4}He DILUTION REFRIGERATOR USING NOVEL TYPES OF HEAT EXCHANGERS. Wiedemann, W.; Probst, C.; Kraus, J. (Bayerische Akademie der Wissenschaften, Munich). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 73-8(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Information is given on the development and operation of a dilution ^{3}He–^{4}He refrigerator using electron-beam-welded heat exchangers made of high-purity silver. The essential characteristics of these exchangers are their low flow resistance and high efficiency. The 1°K bath of the refrigerator is replaced by a closed Joule–Thomson circuit operating with a precooling stage at 4.2°K. (France)

45436 PROPOSAL TO DECREASE THE HEAT RESISTANCE OF HEAT EXCHANGERS IN ^{3}He–^{4}He DILUTION REFRIGERATORS. Blaisse, B. S. (Delft Univ. of Tech., Netherlands). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 79-82(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

A method of reducing the Kapitza resistance of the liquid-solid interfaces in a dilution refrigerator is presented. For a given frequency, the acoustic impedances for longitudinal waves at normal incidence are perfectly matched, if the sheet separating two identical liquids has a thickness $d = m\lambda_1/2$ (λ_1 is the wavelength in the layer material, m is an integer); this is true for any nonabsorbing material. At a temperature T = 0.05°K the principal phonon frequency is nearly $\nu = 3 \times 10^9$ Hz. If a material, such as nylon, is used (the sound propagation velocity is c = 2600 m/s), the thickness must be 0.4 μ for m = 1. The strength of the thin sheet must be sufficient to enable it to resist the pressure differences occurring inside the dilution refrigerator. This may be achieved by use of a thin plastic or metallic sheet clamped between two metallic grids. The diameters of the holes in these grids must be sufficiently small (ϕ = 2000 d for example). A large heat exchanger surface may be obtained using a number of such grids mounted in parallel. (France)

45437 1-kW SUPERCONDUCTING AC GENERATOR UTILIZING SUPERCONDUCTING ROTATING SHIELDS. Kawabe, U.; Kimura, H.; Kudo, M. (Hitachi, Ltd., Tokyo). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 141-5(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

A superconducting rotary ac generator utilizing the magnetic screening between pairs of hard superconducting plates in a transverse magnetic field is described. The mechanism differs from that (due to Meissner effect) of the superconducting rotary energy convector described by Pierro. Prototype III was tested in liquid helium at 4.2°K and enabled the performance of this type of generator to be evaluated. The model consists essentially of a superconducting rotor with many pairs of trapezoidal plates made of sintered Nb_3Sn, copper armature coils and teflon bushes. In operation at 750 rpm with a load resistor of 25 ohm in a field of 19.6 kG, prototype III supplied, at a frequency of 50 Hz, a maximum output power of 940 W. The total loss deduced from the rate of evaporation of liquid He is 82.2 V. The electrical efficiency is 92%. (France)

45438 AC LOSSES IN SUPERCONDUCTING WIRES. Eastham, A. R.; Rhodes, R. G. (Warwick Univ., Coventry, Eng.). Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 147-53(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Alternating currents (20 to 1000 Hz) reaching 100 A were used to supply, at 4.2°K, various types of superconducting bifilar wound wires. The corresponding losses were measured by the helium boil-off method. The measured values of the losses from 0.01-inch wires of various manufacturers are given. The effects of copper cladding on the losses from a single-filament composite wire were calculated; the results are in good agreement with the experiments. Multifilament composite wires with losses equivalent to those from single-filament wires of the same diameter were also studied, and the effect of filament size, twist, and matrix resistivity was established. Experimental results show that transposition of individual filaments may lead to a reduction in the ac losses compared to twisted wires. The effect on losses of the number of wires in a transposed cable of NbTi was also studied. (France)

45439 HELIUM REFRIGERATOR PRODUCING 130 WATTS AT 4.5°K CONNECTED TO AN ELECTRON IRRADIATION DEWAR. Depierre, Y. (CEA, Grenoble, France); Verdier, J.; Artiguebieille, P.; Marinet, D.; Solente, P. Bull. Inst. Int. Froid, Annexe, Suppl.; No. 2, 223-30(1970). (In French).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

Cryogenic refrigeration equipment described includes: a helium refrigerator producing 130 watts at 4.5°K and a two-stage expansion and irradiation dewar containing the sample which is immersed in a liquid helium bath. The refrigerator works automatically in a closed Claude cycle with a cold-gas-bearing turbine producing a refrigeration power between 12 and 22°K. A liquid nitrogen heat exchanger provides refrigerating capacity at 80°K. The regulation equipment ensures the stability and long term reliability. (France)

45440 ^{3}He CRYOSTAT FOR NUCLEAR ORIENTATION BY ADIABATIC DEMAGNETIZATION WITH A SUPERCONDUCTING SOLENOID. Iwata, S. (Kyoto Univ.); Yoshida, H.; Hashimoto, T.; (and others). Bull. Inst. Int. Froid, Annexe, Suppl; No. 2, 233-6(1970).

From Meeting of Commission I of the International Institute of Refrigeration; Tokyo, Japan (11 Sep 1970). See CONF-700964.

An apparatus designed to be used in experiments on the statistics of nuclear orientation is described. It consists of a ^{3}He cryostat with a superconducting solenoid providing facilities for adiabatic demagnetization. The technical problems involved are examined. (France)

45441 ANALYSIS OF HEAT EXCHANGERS FOR DILUTION REFRIGERATORS. Siegwarth, J. D.; Radebaugh, Ray (Inst. for Basic Standards, Boulder, Colo.). Rev. Sci. Instrum.; 42: No. 8, 1111-19(Aug 1971).

Numerical calculations of the behavior of dilution refrigerator heat exchangers are discussed and some results for both discrete and continuous exchangers are presented. It is shown that thermal conductance along the stream is negligible for a typical continuous exchanger of the coaxial tube type, but becomes a dominant feature of a typical discrete exchanger operating below about 50 mK and degrades the performance considerably. A simple design change can be made that reduces the conductance along the liquid and improves the performance of such an exchanger. A simple means of determining whether conductivity is important in either continuous or discrete exchangers is given. (auth)

Plasma and Thermonuclear Physics

45442 (MATT-856) ON-LINE PROCESSING OF DATA FROM LARGE SCALE EXPERIMENTS AT PPL. Thompson, P. A.; Hutar, D. E. (Princeton Univ., N. J. Plasma Physics Lab.). Jul 1971. Contract AT(30-1)-1238. 25p. (CONF-710418-18). Dep. NTIS.

From fourth symposium on engineering problems of fusion research; Washington, D. C. (20 Apr 1971).

DAS-1800, a data acquisition system built around an IBM-1800 computer, has been installed and is being used in conjunction with the larger experimental machines at PPL. An enumeration of the purchased equipment and the rationale for choosing it are given, as well as the overall philosophy and some details of peripheral equipment designed and fabricated in house. Software, including IBM-supplied monitors, locally written systems programs, and the experimenters' user programs, is discussed. Finally, a summary is given of DAS-1800 applications to the experiments on the PPL machines. (auth)

45443 (ORNL-4688) THERMONUCLEAR DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1970. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 142p. Dep. NTIS.

Separate abstracts were prepared for the nine main sections. (M.O.W.)

For abstracts of individual sections see: 45300, 45450–45453, 45494, and 45507–45509.

45444 PLASMA STATE. Shohet, Juda Leon. New York; Academic Press, Inc. (1971). 342p. $13.50.

This introduction presents the fundamentals of the plasma state. The following chapters are included: (1) the plasma state; (2) collisions and collisional processes; (3) motion of isolated charged particles; (4) plasma statistical mechanics, (5) statistics of collisions and fluid behavior; (6) simple applications of the fluid and statistical models of a plasma; (7) waves in cold plasma; (8) waves in hot plasma; (9) plasma kinetic theory; and (10) radiation processes and correlation. (M.O.W.)

Confinement and Heating

Refer also to abstracts 45507 and 45616.

45445 (AD-720675) PLASMA HEATING DUE TO THE BEAM CYCLOTRON INSTABILITY. McBride, John B.; Lampe, Martin; Manheimer, Wallace M.; Orens, Joseph H.; Sudan, Ravindra N. (Naval Research Lab., Washington, D. C.). Feb 1971. 19p. (NRL-MR-2216). NTIS.

The nonlinear evolution of a plasma that is beam-cyclotron unstable is studied, with emphasis on the expected amount of plasma heating. (auth) (USGRDR)

45446 (EUR-CEA-FC-591) SYNTHESIS REPORT ON THE PROJECT OF NEUTRAL PARTICLE INJECTION IN A QUADRUPOLAR COIL. Dei-Cas, R.; Hennion, F.; Tachon, J.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1971. 31p. (In French). Dep. NTIS (U. S. Sales Only).

A review is made of the work done for preparing the experiment on neutral particle injections in a quadrupolar coil. The coil, the cryostats, and the injector are described. The aim of this experiment is to confine a hot ion plasma and to reach a collisional equilibrium state in open devices. (France)

45447 (NP-18916) RATIO OF LONGITUDINAL AND TRANSVERSE DIFFUSION COEFFICIENTS IN ARGON SHF DISCHARGE PLASMA. Budnikov, V. N.; Novik, K. M.; Obukhov, A. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some results of determination of the ratio of longitudinal and transverse diffusion coefficients in argon plasma are given. They were obtained from the analysis of longitudinal density distribution outside the active region of the microwave discharge. The experiments were carried out with axial magnetic field about 3000 Oe. The discharge tube was 70 cm long and 2.5 cm in diameter. The plasma density was 10^{10} to 10^{12} cm^{-3} and T_e was 2 to 10 eV. The ratio $D_{\parallel}/D_{\perp}$ was found to be constant and equal to 25 at pressures 3×10^{-2} to 3×10^{-3} mm Hg. (auth)

45448 (NP-18917) MEASUREMENT OF TRANSVERSE DIFFUSION COEFFICIENTS IN SHF PLASMA. Bulyginskii, D. G.; Vil'dzhyunas, M. I.; Poloskin, B. P.; Utochkin, B. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Plasma created in a straight mirror trap of the following parameters is discussed: length l = 100 cm, diameter d = 12.6 cm, mirror ratio ~2, magnetic field in the center of system H = 2 to 3.5 kG, microwave power 30 W, frequency ~8.8 GHz, half-period of the field H of 160 msec, and hydrogen pressure from 4×10^{-5} to 2×10^{-3} torr. The characteristics of the plasma gen-

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erated by electron cyclotron resonance were: T_e = 3 to 8 eV, T_i = 1 eV, and $n_e = 1$ to 3×10^{10} cm^{-3}. Measurements were made of the normal diffusion coefficient $D_\perp$ due to azimuthal fluctuating electric fields E_φ versus H and P, using the formula $D_\perp = (c^2E_\varphi^2/H^2)\int_{-\infty}^{\infty} \Psi_E(\tau)d\tau$ where $\Psi_E(\tau)$ is the normalized autocorrelation function of E_φ. The results presented show that $D_\perp$ is close to the Bohm diffusion at high pressure. This was confirmed by probe measurements treated according to Bertotti's theory. But at lower pressure, when the electron mean free path becomes comparable to the trap dimension, a sharp rise of $\overline{E_\varphi^2}$ is observed. The latter may be accounted for by the appearance of a group of fast electrons accelerated by the resonance wave. The experimentally observed anomalous diffusion is considered as being due to the low-frequency broad spectrum turbulence, which develops from the drift waves near the plasma surface. (auth)

45449 (NP–18947) GENERAL RULES FOR CURRENT PROCESSES IN PLASMA HEATING IN PULSED Z-DISCHARGES. Dubovoi, L. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that in plasma heating processes in pulsed Z discharges, the gas-kinetic pressure nT of particles is related to the discharge current field B_φ by the general law $nT \simeq \beta_\varphi(B_\varphi^2/g\pi)$, (where β_φ = const ~1), for most of the present-day experiments. Conclusions from this relation and generality of its character are discussed. (auth)

45450 (ORNL–4688, pp 24-43) MIRROR CONFINEMENT. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

The primary experimental effort was aimed at understanding density limitations of target plasmas produced by ECH in minimum-B geometries. In addition to the studies of such plasmas in INTEREM at $B_0 \leq 3.6$ kG, the construction of the higher-field IMP facility was completed, and the superconducting mirror-quadrupole coil configuration was tested to B_0 = 9 kG with |B| = 16 kG at the last closed field contour. The microwave power sources of 1 kW, 36 GHz (for resonant heating) and 55 GHz (1 kW at present, 10 kW planned for nonresonant heating) were also completed. Experiments in INTEREM show target plasmas with $n_e/n_0 \approx 10$ may be produced stably by combining 0.05 W/cm^3 resonant and ~0.5 W/cm^3 nonresonant power. In this case $\beta \sim 0.5$ averaged over the ~1.2-liter plasma volume. The volume is determined from axial bremsstrahlung measurements and radial scans of ionization current. The peak plasma density is 3×10^{11} cm^{-3} ($\omega_{pe}^2/\omega_{ce}^2 \sim 1/3$) and the mean energy ~1 to 1.5 MeV, depending on power. A second instability mode (present when only resonant heating power is used) was isolated and identified as an unstable electromagnetic (whistler) mode. Energetic atom injection experiments were initiated, and the trapped ion fraction, when injecting into the target plasmas, yields n_e/n_0 in general agreement with the other measurements. Ion density, however, with ~20 mA of 3-keV H_0^0 beam, is only $\sim 8 \times 10^7$ cm^{-3} ($\omega_{pe}^2/\omega_{ce}^2 \cong 0.1$). Before shutting down the simple mirror IMP configuration (phase I), a series of axial and radial feedback experiments were performed in a relatively unsuccessful effort to stabilize observed flute instabilities in the ECH target plasma. Electron densities, limited by unstable flutes to $\sim 10^9 - 10^{11}$ cm^{-3}, were raised only slightly when feedback was used, in spite of the suppression of those modes seen without feedback. (auth)

45451 (ORNL–4688, pp 67-76) HIGH-BETA PLASMAS. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

The tentative identification of an electrostatic instability in resonantly heated microwave plasmas was made. This instability, characterized by rf emission at half the heating frequency, can be suppressed by microwave heating with frequencies much higher than that required for resonance (upper off-resonance heating). Other work is presented on the annular characteristics of high-β plasma and the variation of stored energy with resonant mirror ratio. The construction of the canted mirror facility is described. This facility approximates a sector of a bumpy torus. Some speculations on high-β hot-electron plasma confinement in a bumpy torus are presented. Finally, some theoretical heating studies are described. (auth)

45452 (ORNL–4688, pp 77-91) TURBULENT HEATING. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

Excellent correlation between theoretical calculations and experimental results was obtained; it was found that the ion-heating process is due to several processes involving a radial electric field—not an axial beam–plasma interaction as previously thought. The axial electron beams used to generate plasma in Burnout V were replaced by axial plasma torches. The resulting density, rotation, radiation, lifetime, electron temperature, and ion temperature of the plasma in the new device, Burnout VI, are described. Some additional "basic" experiments and computations were performed by students on nonlinear ion-wave behavior, turbulent heating, and pseudowave effects. (auth)

45453 (ORNL–4688, pp 92-101) ENERGETIC-PARTICLE INJECTION. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

Ion sources were developed that will produce ampere-equivalent usable energetic neutral-particle beams. These beams are adequate for doing pertinent plasma physics experiments by filling magnetic mirror devices or heating the plasma in toroidal devices. The system uses a duoPIGatron ion source with 5-cm-diam gridded extraction electrodes to produce a steady-state 1-A ion beam at an energy up to 5 keV or a 0.1-sec pulsed beam up to 2.8 A at energies of 20 to 40 keV. Studies have confirmed that better performance may be possible from these systems when the plasma density in the source is made more uniform. These results from multi-aperture extraction systems, which can be scaled to larger sizes, indicate that one should be able to build 10-A beam injection modules at an energy of tens of kiloelectron volts. (auth)

45454 HEATING OF A THETA-PINCH PLASMA BY A CO_2 LASER. Martineau, J.; Pepin, H. (Univ. of Quebec, Varennes). Can. J. Phys.; 49: No. 12, 1685-7(15 Jun 1971).

The heating of a theta-pinch deuterium plasma by a CO_2 laser was studied as a function of pulse duration and energy. A hydrodynamical approach was used with temperatures and densities assumed uniform in a fully ionized plasma. This model takes into account the dynamics of the magnetic field, the axial and radial magnetic confinement, the shape of the laser pulse, and energy transferred to the plasma by inverse bremsstrahlung. The results (dimensions, temperature, absorbed power) are interpreted to show that an increase in pulse duration results in higher electron and ion temperature. (auth) (Canada)

45455 CO_2 LASER HEATING OF AN INHOMOGENEOUS SLAB OF DEUTERIUM THETA-PINCH PLASMA. Martineau, J. (Institut National de la Recherche Scientifique, Varennes, Quebec). Phys. Lett.; 36A: No. 1, 67-8(2 Aug 1971).

The hydrodynamic behavior of a deuterium theta-pinch plasma is described when transversally irradiated by a CO_2 pulsed laser, taking into account the diffusion of the magnetic field. (auth)

Diagnostics

Refer also to abstracts 45476, 45487, and 45507.

45456 (NP–18946) MEASUREMENT OF PLASMA PARAMETERS IN STRONG hf DISCHARGES. Dubovoi, L. V.; Ivanov, B. A.; Chernobrovin, V. I. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

An attempt is made to use a corpuscular diagnostic method for defining the local characteristics of the skinned rf discharge. Obtained values of plasma density and thermal skin-layer thickness are in agreement with calculational and measurement results obtained with independent methods. The measurement results of the ion distribution function in the turbulent discharge are given. (auth)

45457 SPECTROMETRIC MEASUREMENTS IN AN ARC JET AND TEMPERATURE PROFILES. Rienzi, S. A.; Angelin, L. (Univ., Padua). Rev. Int. Hautes Temp. Refract.; 8: No. 1, 5-10(Jan-Mar 1971)

The temperature profiles and electron density associated with refractory oxides introduced into an argon plasma stream were determined from spectrometric measurements. The heat balance equation and the enthalpy are discussed. The accuracy of the results is dependent upon experimental error and uncertainties in parameters concerning the density and plasma composition. The results obtained are compared with those of other workers. (auth) (France)

Kinetics (General)

45458 (AD–719885) PLASMA PROPAGATION INTO LOW-PRESSURE GAS AND PLASMA IN A MAGNETIC FIELD. Final Scientific Report, October 1, 1965–September 30, 1968. Kaufman, A. S. (Hebrew Univ., Jerusalem (Israel). Dept. of Physics). 31 Aug 1970. Contract AF61(052)-891. 12p. (AFCRL–70-604). NTIS.

The propagation of plasma into an ambient gas at low pressure in the presence of an external electric field was investigated experimentally and theoretically. The important feature is the slow speed of plasma expansion which is of interest in the prob-

lem of plasma containment. A possible connection with space physics was sought but not found. The positive column of an arc discharge with and without an external magnetic field was investigated spectroscopically using the singlet–triplet ratio method in helium. Analysis of results showed that the electron-velocity distribution function was not Maxwellian near the wall of the discharge tube. Transfer of the uniform column to the helical form at the critical value of the magnetic field was demonstrated without perturbing the plasma in any way. (auth) (USGRDR)

45459 (EUR-CEA-FC-596) USE OF A HIGH MODE MICROWAVE CAVITY AS A PLASMA ACCELERATOR USING THE ELECTRON CYCLOTRON RESONANCE. Jacquot, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1971. 21p. (In French). Dep. NTIS (U. S. Sales Only).

The dimensions of a microwave cavity with a high T.E. mode are determined. The high pumping rate obtained in this cavity should permit acceleration of plasmas in a new PIEIADE-type device. (auth) (France)

45460 METHOD FOR EXPERIMENTAL DETERMINATION OF THE THERMODYNAMIC QUANTITIES OF A NONIDEAL PLASMA. Andreev, S. I.; Gavrilov, V. E. High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1176-9(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1256-9(Nov-Dec 1970).

A method is suggested for the simultaneous experimental determination of the internal energy of a plasma, its temperature, and its volume per heavy particle. The method is based on analyzing the power balance for pulse heating of the investigated gas in a closed volume. (auth)

45461 ELECTRICAL PROPERTIES OF HIGH PRESSURE PULSED-DISCHARGE PLASMAS IN INERT GASES. Bakeev, A. A.; Rovinskii, R. E. High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1055-60(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1121-7 (Nov-Dec 1970).

Empirical relations between the electric conductivity and temperature for xenon and argon are obtained. They differ from Spitzer's formula in the lower value of the coefficient. For equal temperature, the electric conductivity in a pulsed argon discharge (pressure 10 to 20 atm) is lower than the experimental data for the electric conductivity of stationary argon arcs at a pressure of 1 atm. A relation is obtained that connects the current density with the temperature, pressure, and type of gas and which coincides qualitatively and quantitatively with the experimental data for xenon and argon. (auth)

Kinetics (Experimental)

45462 (AD-720335) MOMENTUM TRANSFER IN PLASMA FLOWS AT HIGH ALFVEN MACH NUMBERS. Friedman, Herbert W.; Patrick, Richard M. (Avco-Everett Research Lab., Everett, Mass.). Feb 1971. Contract DASA01-67-C-0131. 65p. (AERL-RR-355). NTIS.

Momentum coupling between two interpenetrating plasmas in the presence of a weak magnetic field was studied experimentally. A coaxial plasma gun ionizes and accelerates ionized aluminum into a low-pressure background gas that was preionized by ultraviolet radiation from the gun. A steady magnetic field is applied parallel to the aluminum flow with maximum amplitude such that the ratio of dynamic aluminum pressure to magnetic pressure is of order 1000, the ion gyro radius is much larger than overall flow scale, and the Alfven Mach number is greater than 10. Under these conditions, the field should have no direct influence on the deceleration rate of the aluminum plasma. Streak-camera photographs show little momentum transfer between the two plasmas when no field is applied, verifying collisionless conditions and almost complete transfer when the field is applied. Magnetic field probes show that the applied field has been pushed aside by the aluminum plasma creating a field-free bubble region. The scale length of the electron density gradients was measured with a holographic interferometer, indicating momentum transfer lengths less than 1 cm, two orders of magnitude less than the ion gyro radius. (auth) (USGRDR)

45463 (AD-720713) INVESTIGATIONS OF IONIC SPECIES IN HIGH-PRESSURE CESIUM DISCHARGES. Annual Report No. 5, March 1, 1970–February 28, 1971. Chanin, Lorne M. (Minnesota Univ., Minneapolis. Dept. of Electrical Engineering). Contract N00014-67-A-0113-002. 44p. NTIS.

Ion sampling measurements were made on cesium plasmas for normalized pressures from .0001 to 1 torr using dc as well as rf excitation. For dc discharges, sampling was undertaken through both the anode and cathode. The major cesium ions observed were Cs^+, Cs^{2+}, and Cs^{3+}. Measurements were made of the ion current ratios as a function of normalized pressure. Comparison of the observed dependencies with those predicted using steady state-kinetics provides estimates of the rate coefficients. (auth) (USGRDR)

45464 (MATT-836) PRODUCTION OF INTENSE ION BEAMS BY HIGH-FREQUENCY ELECTRIC FIELDS. Sindoni, E.; Eubank, H. P. (Princeton Univ., N. J. Plasma Physics Lab.). Apr 1971. Contract AT(30-1)-1238. 20p. Dep. NTIS.

Electron cyclotron resonance plasma accelerators as a source of high-intensity, low-energy (keV) ions in which ion current and electron and ion energies are related to rf power and gas pressure were investigated experimentally. (auth)

45465 CATHODE REGION OF A QUASI-STEADY MAGNETOPLASMADYNAMIC ARCJET. Turchi, Peter John. Princeton, N. J.; Princeton Univ. (1970). 151p. University Microfilms Order No. 71-14,425.

Thesis.

A magnetoplasmadynamic discharge is examined near the cathode of a 2.5-MW, quasi-steady, self-field arcjet. High-speed photography shows a concentration of arc luminosity in the cathode region, while detailed measurements with electric and magnetic field probes indicate that 85% of the total arc power is deposited within one base diameter of the cathode surface. Ion energies are shown to be proportional to the voltage drop in the cathode region even though current conduction is accomplished primarily by electrons in a tensor manner. It is found that a high-speed plasma flow is delivered to the cathode where it is converted into a useful exhaust jet in a thin, high-density layer at the cathode surface. Local measurements of electron temperature and estimates of electron density, made within the discharge and exhaust jet using a twin Langmuir-probe technique, indicate a nearly uniform electron temperature of about 1.5 eV throughout the quasi-steady arcjet flow. Theoretical considerations of current conduction and plasma acceleration processes near the cathode are correlated with the experimental evidence and lead to relationships among overall arcjet properties. In particular, ion kinetic energies in the exhaust jet should be comparable to the arc voltage, exhaust velocity and arc impedance should be proportional, and the influence of insulator ablation should become important when the input mass flow is fully ionized by the arc. (Diss. Abstr. Int., B)

45466 PROFILE MEASUREMENTS OF THE LINES He I 4471 AND 4922 IN A DENSE PLASMA. Nelson, Robert Howard. Vancouver, British Columbia; Univ. of British Columbia (1970). National Library of Canada, Ottawa.

Thesis.

Detailed measurements were made of the profiles of the lines He I 4471 and 4922 Å in a pulsed arc plasma, for electron densities in the range 3×10^{16} to 10^{17} cm^{-3} and at a temperature of 4.5 eV. Photoelectric detection was employed in a rapid-scan spectrometer. The relative intensities agreed well with the computed values, but the component peaks for each line were closer together. (Diss. Abstr. Int., B)

45467 DISTRIBUTION OF LUMINESCENCE OF EXCITED IONS AND THE STUDY OF OSCILLATIONS OF FLOATING POTENTIAL AND MAGNETIC FIELD OF PLASMA IN CROSSED E AND H FIELDS. Guslyakova, N. F.; Vaulin, E. P. Zh. Prikl. Spektrosk.; 13: 360-2(Aug 1970). (In Russian).

The critical value of external magnetic field strength was determined, during which characteristics of the Hall magnetic field, intensities of luminescence of the spectral lines of argon ions, and the floating potential are significantly changed. It was found that the frequencies of oscillations of all of the parameters studied were equal and were not changed with change of discharge current, pressure, and external field B_z in the range $B_z < B_{z(cr)}$. In the range $B_z > B_{z(cr)}$, the frequency relations of the parameters are linear and are changed with change of discharge current and pressure. (tr-auth)

45468 STUDIES OF DECAYING HELIUM PLASMA. Gippius, E. F.; Kolesnikov, V. N.; Shumskaya, L. I. Zh. Prikl. Spektrosk.; 13: 208-11(Aug 1970). (In Russian).

Changes of parameters of strongly ionized helium plasma in the early stages of decay (~30 μsec) were studied, and dynamics of occupancy of excited levels of atoms and ions in this stage were traced. Information on existence in the plasma of a non-Maxwellian group of fast electrons up to densities 10^{16} cm^{-3} was obtained. Additional (nonrecombining) maximum intensities of the continuum and the lines were discovered, which are interpreted as resulting from heating of the gas by converging shock waves. The value of the recombination coefficient for doubly ionized helium turned out to be approximately two orders less than calculated. (tr-auth)

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45469 EFFECT OF A MAGNETIC FIELD ON THE PLASMA OF ELECTRODELESS DISCHARGES. Mitin, R. V.; Pryadkin, K. K.; Zvyagintsev, A. V. (Kharkov Physical-Technical Inst.). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1073-8(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1142-8(Nov-Dec 1970).

The results of an experimental study of the rotation of the plasma in electrodeless high-frequency discharges at high pressure in an external magnetic field are discussed. The relationship of the rotational frequency of the discharge to the type of gas (Ne, Ar, Kr, Xe), intensity of the magnetic field, and pressure in a range from 0.5 to 2 atm was established. The rotation is believed to be due to electrophoresis in a gas-discharge plasma. (auth)

Kinetics (Theoretical)

45470 (AD-719926) BOUNDARY PROBLEMS AT PLANE INTERFACE BETWEEN VACUUM AND VLASOV PLASMA. Sakuda, Kyohei (New York Univ., N. Y. Dept. of Electrical Engineering). Jan 1971. Contracts N00014-67-A-0467-0018; Nonr-285(66). 72p. (TR-402-5). NTIS.

The boundary problem at the interface between vacuum and plasma is studied. The plasma is one-component and homogeneous, but, anisotropic due to an external static magnetic field. The plasma is described by the linearized Vlasov equation. In order to obtain the field quantities, i.e., first-order electric and magnetic field, and the velocity distribution function, the dyadic Green's function is obtained, then by applying the completeness relationship, the complete set of eigenvectors are derived. Using superposition, all first-order quantities are obtained in terms of the complete set of eigenvectors once the expansion coefficients are determined. The expansion coefficients are determined by the speculum assumption, the causality condition, and outgoing wave condition. (auth) (USGRDR)

45471 (AD-874659) STUDY OF FINITE MOLIERE SCATTERING. Rossbach, Dennis R. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1970. 140p. NTIS.

Thesis.

An improved apparatus was constructed for the measurement of small-angle Moliere scattering in a plasma, and preliminary data were obtained using the device. An extension of Moliere's cross section expansion, $F^3\Phi$, was derived, and accurate finite beam-detector calculations for the Moliere theory were made using a set of programs developed for this purpose. Also, comparison of the Moliere theory and Monte Carlo predictions was made to check the validity of several assumptions. The Monte Carlo predictions agree very well with the Moliere calculation, and suggest that multiple scattering in a plasma is independent of the number density profile in the interaction zone to at least first order. (auth) (USGRDR)

45472 (NP-18942) INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PLASMA. Rukhadze, A. A.; Rukhlin, V. G. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

Plasma interaction was studied for the injection of a low-density relativistic electron beam. Under the conditions $r_0 > c/\omega_p$, where r is the beam radius and ω_p is the plasma frequency, all plasma disturbance is localized in the region of the electron beam itself, whereupon the currents induced in the plasma tend to compensate for the magnetic field and facilitate the beam's injection into the plasma. If the beam's injection time is $T > T_0 = 1/\nu(r\omega_p/c)^2$, where ν = the frequency of electron collision in the plasma, then compensation of the magnetic field occurs at distances $Z < Z_0 - uT_0$ from the leading front of the beam, where u is the directed velocity of electrons. Therefore, in the case of an electron beam carrying a high current, when the magnetic energy of the beam's intrinsic current is larger than the kinetic energy of the electrons, the facilitated injection is feasible in the dense plasma only under the conditions when $\omega_p > c/r_0$ and $T < T_0$. (tr-auth)

45473 (SC-RR-710089) TEMPORAL BEHAVIOR OF VOLUME DENSITIES AND CHARGED PARTICLE WALL CURRENTS IN A RECOMBINATION AND DIFFUSION DOMINATED AFTERGLOW PLASMA. Gerber, R. A.; Gusinow, M. A.; Freeman, J. R. (Sandia Labs., Albuquerque, N. Mex.). Mar 1971. 83p. Dep. NTIS.

Solutions of the continuity equation for a cylindrically symmetric isothermal plasma subject to recombination and ambipolar diffusion are presented. The calculations are performed for a wide variety of radius-to-length ratios, initial density distributions, and recombination coefficients. Also included are calculations for a diffusion-controlled afterglow with no recombination. Results are presented for the wall currents as a function of time and for the charged-particle densities as a function of position and time. These results indicate that in many instances it is not possible to infer the central density decay from the time variation of the wall current. (auth)

45474 NONEQUILIBRIUM PLASMA BOUNDARY LAYER OVER A CATHODE. Seals, Robert Kincaid Jr. Raleigh, N. C.; North Carolina State Univ. (1970). 68p. University Microfilms Order No. 71-13,973.

Thesis.

An analysis of the nonequilibrium plasma boundary layer over a cathode in the presence of a magnetic field is presented. The case considered is that where the Debye length is less than the mean free paths and the Larmor radii, and where the thermal and nonequilibrium effects are important. The solution is obtained by matching the sheath solution and the solution of the conservation equations of the plasma constituents. The transport properties for a partially ionized gas in the presence of nonequilibrium ionization and magnetic fields are obtained from appropriate equations derived by the thirteen-moment method. Local similarity is assumed, and the problem is solved numerically using an integral method on an IBM Model 360-75 digital computer. Results are presented for a range of values of magnetic fields and axial distance and for two values of wall temperature. The results indicate that the heat flux at the wall, the current density, and the electron temperature all tend to increase with increasing magnetic induction. (Diss. Abstr. Int., B)

45475 CALCULATION OF PLASMA DECAY. Gudzenko, L. I.; Filippov, S. S.; Yakovlenko, S. I. Zh. Prikl. Spektrosk.; 13: 357-9(Aug 1970). (In Russian).

Equations that describe change of concentration in different quantum states and variations of temperatures of atoms, protons, and electrons during decay of an inhomogeneous plasma of atomic hydrogen are derived. Recombination of hydrogen during scattering of plasma clusters is considered. The influence of ambipolar diffusion on the recombination of plasma in cylindrical containers is discussed. (tr-auth)

45476 ENHANCED SCATTERING OF LASER LIGHT BY OPTICAL MIXING IN A PLASMA. Stansfield, B. L.; Nodwell, R.; Meyer, J. (Univ. of British Columbia, Vancouver). Phys. Rev. Lett.; 26: No. 20, 1219-21(17 May 1971).

The enhancement of the scattered signal due to the mixing of two optical beams in a plasma is observed. The two beams are produced in a dual-cavity organic-dye laser pumped by a Q-switched ruby laser. The presence of enhanced oscillations is demonstrated by a 50% increase in the intensity of the satellite in the scattered light spectrum of a third beam. (auth)

45477 NUMERICAL EXPERIMENTS ON THE NONLINEAR FOKKER-PLANCK EQUATION. Braun, Jean-Claude (Univ., Nancy). Compt. Rend., Ser. B; 272: No. 20, 1178-81(17 May 1971). (In French).

The effects of collisions on both the first-order component of the self-consistent field and the second-order perturbation of the electron distribution function were studied. Numerical calculations were made from a representation of the functions in a Fourier-Hermite space, in the case of longitudinal electron oscillations. (France)

45478 PHYSICAL PROCESSES IN A LOW-DENSITY RELATIVISTIC PLASMA. Bisnovatyi-Kogan, G. S.; Zel'dovich, Ya. B.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 1, 17-22(Jul-Aug 1971).

Translated from Astron. Zh.; 48: No. 1, 24-31(Jan-Feb 1971).

The kinetics of the creation and annihilation of positrons is studied in an optically thin plasma far from thermodynamic equilibrium. At temperatures lower than a certain $T_c \sim 20$ MeV there exists a stationary concentration in which the ratio n_+/n_- is proportional to α^2 (where $\alpha = e^2/\hbar c = 1/137$) and is temperature dependent. At temperatures above 20 MeV the stationary state is absent. The case of a plasma optically thick to Compton scattering was also investigated. Possible astrophysical consequences of the studies are examined briefly. (auth)

45479 HYDROMAGNETIC EQUATIONS OF RAREFIED PLASMA. Milant'ev, V. P. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 3-11(Jan-Feb 1971). (In Russian).

General hydromagnetic equations were obtained for collisional plasma that respond to ordering, with calculation of magnetic viscosity and thermal conductivity. The equations turn out to be open, since they contain the fourth moments. Calculating these moments, for example, according to the method of Grad, it is possible to close the system of equations obtained. The

form of macroscopic equations of rarefied plasma in a magnetic field depends strongly on the procedure of regulating physical quantities. Examples from the literature are given. (tr-auth)

45480 PROBLEM OF MAGNETIC FIELD IN NONHOMOGENEOUS TURBULENT FLOW. Vainshtein, S. I. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 12-18(Jan-Feb 1971). (In Russian).

A specific model of magnetohydrodynamic turbulence is considered. The most essential assumption utilized is the disregard of the velocity correlation times with utilization of selective summation by perturbation theory. An accurate equation was obtained for the magnetic field for the case when the mean-square value of velocity depends on the coordinates, i.e., when turbulence is nonhomogeneous. The results make it possible to obtain macroscopic Maxwell equations. (tr-auth)

45481 PROBLEM OF ELECTRIC FIELD OF ELECTRODE WITH THE NEAR-ELECTRODE FALL OF POTENTIAL IN MEDIA WITH TENSOR CONDUCTIVITY. Emets, Yu. P. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 19-23(Jan-Feb 1971). (In Russian).

The nonlinear distribution of current at the electrodes of finite dimensions with near-electrode layers is studied, in which potential locally depends on the current density. The electrode is in contact with the medium, which possesses anisotropic conductivities induced by the Hall effect. The problem reduces to solution of a nonlinear integro-differential equation. It is shown that the structure of the field is determined by the value of the Hall parameter and by the volt-ampere characteristics in the near-electrode layer. (tr-auth)

45482 PLANE ONE-DIMENSIONAL STATIONARY FLOW OF IDEAL CHARGED GAS IN ITS OWN ELECTRIC FIELD. Nagel, Yu. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 24-32(Jan-Feb 1971). (In Russian).

The problem concerning plane one-dimensional flow in the intrinsic electric field of incompressible gas, which consists of a neutral and also a charged component, was studied earlier by Stuetzer (Rev. Sci. Instr. 32: 16-22(1961)). His results were accurate when the ratio of electrostatic to hydraulic pressure was small in comparison with unity. An analogous problem is considered here for a compressed gas on a more general premise— when this ratio is comparable to unity. Three cases are analyzed: (1) the relative velocity of charged and neutral particles is equal to zero, (2) the relative velocities are different from zero, but flow can be considered isentropic, and (3) nonisentropic flow, i.e., when it is not possible to neglect irreversible losses that emerge by the relative motion of charged and neutral particles. (tr-auth)

45483 NONSTATIONARY WAVES PROPAGATING LONGITUDINALLY ALONG MAGNETIC FIELD IN A PLASMA. Berezin, Yu. A.; Dudnikova, G. I. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 141-3(Jan-Feb 1971). (In Russian).

Numerical solutions for shock wave propagation along the magnetic field in a cold rarefied plasma are given. Parameters of the shock wave in the quasi-stationary phase for small Mach numbers ($M \leq 2$) are given. At $M = 4$, the velocity profiles and particle densities tend to be discontinuous. (tr-auth)

45484 DECAY OF A HIGHLY IONIZED PLASMA. Son, E. E. High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1061-4 (Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1128-32 (Nov-Dec 1970).

The relaxation of a hydrogen and potassium plasma as its electrons are quickly cooled by helium atoms acting as a thermostat is examined. Calculations are made implicity in such a way as to assure stability of the solution of the system of differential equations that describes the kinetics of the populations for any number of discrete levels. Re-absorption of radiation and heat generation on recombination, which appears to be 2 to 2.5 times lower than the value calculated according to "diffusion" theory, are discussed. The calculation showed the existence of an inversion of populations 5s-4p and 5p-3d for potassium plasma. (auth)

45485 ELECTRON ENERGY BALANCE IN A PLASMA WITH MOLECULAR IMPURITIES. Mnatsakanyan, A. Kh. (Inst. of Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1079-83(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1149-53 (Nov-Dec 1970).

Inelastic collisions between electrons and molecules and between molecules and alkali metal atoms are studied. An expression is derived for the inelastic energy loss of the electrons. Satisfactory agreement with experiment is obtained. The possibility of electron heating by injection of hot molecules into the plasma is discussed. (auth)

45486 THEORY OF HIGH-TEMPERATURE NITROGEN PLASMAS. Maslov, P. G.; Maslov, Yu. P.; Antonov, A. A. (Leningrad State Pedagogical Inst.). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1084-93(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1154-64 (Nov-Dec 1970).

Calculations are carried out on high-temperature nitrogen plasmas at pressures of 0.1 to 100 atm and temperatures of 5,000 to 40,000°K. In this range the specific heat, enthalpy, entropy, Φ^*-potential, compressibility, density, degree of dissociation $X_D N_2$, degree of ionization X_i of atomic nitrogen, and density of current carriers were found. The degrees of dissociation and ionization, the density, the specific conductivity, and the electron density are expressed as functions of T and p. Formulas are derived for calculating the thermodynamic functions of the plasma depending on T and p. On the basis of these formulas, functions are obtained for various temperatures and pressures in the stated range of pressure and temperature. A series of self-consistent equations is presented for the thermodynamic properties of the plasma components under standard conditions. These conditions apply over a very wide range of temperatures. It is shown that the calculation of the thermodynamic and electrical characteristic of nitrogen plasmas, performed by Martinek and found in many references, contains errors that place these calculations in sharp disagreement with Martinek's data on the actual condition of the plasma. (auth)

Production

45487 (ORO-3819-3) COUNTER-STREAMING LASER-PRODUCED PLASMAS. Progress Report, June 1, 1970-April 30, 1971. Koopman, David W. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jun 1971. Contract AT(40-1)-3819. 39p. (BN-698). Dep. NTIS.

Preliminary data are given for the following research areas: (1) Langmuir probes in flowing plasmas, (2) magnetic field assembly, (3) photo-ionization, (4) anomalous plasma attenuation, and (5) ion precursors. (M.O.W.)

45488 (ORO-3819-4) PRECURSOR IONIZATION FRONTS AHEAD OF EXPANDING LASER-PLASMAS. Koopman, David W. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jun 1971. Contract AT(40-1)-3819. 30p. (BN-700). Dep. NTIS.

Fast ionization fronts were experimentally observed to propagate ahead of a laser-produced plasma expanding into low-density background gas. The ionizing wave has a velocity of .3 to 3×10^8 cm/sec and a thickness of 1 to 10 cm, both of which increase with radius of propagation. Langmuir-probe and microwave diagnostics indicate that the wave increases the initial photo-ionization density by a factor of ~3; potential fluctuations exist within the wave that can accelerate electrons to energies above the ionization threshold. Equations describing a collisional ionizing electron wave are solved in an approximate manner to yield relations that agree with many features of the measured phenomena. (auth)

45489 METHOD FOR PRE-PREIONIZATION OF PLASMA. Nolting, Eugene (Univ. of Miami, Coral Gables, Fla.). Rev. Sci. Instrum.; 42: No. 8, 1262-3(Aug 1971).

In the TRISOPS experiment the preionizer coil, composed of three turns of copper ground strap, has an appreciable part of the total inductance of the circuit. About 60% of the 18 kV on the energy-storage capacitor appears across the preionizer coil. A wire with a needle sharp point is attached to the transmission line on the high voltage side of the coil. The point is placed next to the Pyrex vacuum chamber. When the preionizer bank is discharged, the sharp point causes a large electric field to appear in the vicinity of the working gas. This electric field ionizes enough of the neutrals to enable the preionizer to work effectively. A test showed that without the pointed wire a plasma discharge was obtained for only one out of 10 attempts. The addition of the wire gave a plasma discharge every time. It was found that as long as the needle point is kept clean, reliable pre-preionization occurs. (M.O.W.)

45490 IONIZATION RELAXATION FOR STRONG SHOCK WAVES IN GASES. Biberman, L. M.; Mnatsakanyan, A. Kh.; Yakubov, I. T. (Inst. of High Temperatures, Moscow). Usp. Fiz. Nauk; 102: 431-62(Nov 1970). (In Russian).

An attempt is made to clarify relaxation phenomena for shock waves under conditions when ionization is the most important process. The following sections are included: ionization kinetics in low-temperature plasma, energy exchanges between electrons and other plasma components, ionization in the first stage of relaxation, effect of radiation transport on the relaxation processes; structure relaxation zones for strong shock waves, re-

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laxation lengths, nonequilibrium plasma radiation, nonequilibrium radiation maximum for shock waves, and its role in radiation heating with hypersonic flow. (tr-auth)

Stability

Refer also to abstract 45516.

45491 (AD-718954) INSTABILITIES IN MHD ACCELERATORS. Final Report, July 1967-July 1968. Garrison, G. W. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn.). Feb 1971. Contract F40600-71-C-0002. 65p. (AEDC-TR-70-290). NTIS.

A linearized perturbation analysis is used to determine if instabilities can occur in MHD accelerators. When the electrical perturbations are assumed unaffected by the presence of conducting walls, the enthalpy wave has the largest growth rate. The growth rate depends upon the orientation of the current vector to the wave front and the location within the accelerator. When the electrical perturbations are influenced by the presence of the slanted conducting walls, the upstream-moving magneto-acoustic wave is amplified. When steady-state gradients are neglected, the growth rate changes only slightly in both cases. An elevated electron temperature increases the enthalpy wave growth rate in the absence of conducting walls, but has little effect when the conducting walls control the electrical perturbations. The linearized analysis indicates that instabilities can exist in MHD accelerators and the growth rate may be large in some cases. (auth) (USGRDR)

45492 (AD-720773) ION ACOUSTIC WAVES IN A MULTI-ION PLASMA. Fried, Burton D.; White, Roscoe B.; Samec, Thomas K. (California Univ., Los Angeles. Plasma Physics Group). Jan 1971. 23p. (R-86). NTIS.

An exact treatment of the multi-species ion acoustic dispersion relation is given for an argon/helium plasma. Phase velocity and damping are obtained as a function of ion-electron temperature ratio and relative densities of the two species. There are two important modes in the plasma, quite different phase velocities in general, which can be referred to as principal heavy-ion mode and principal light-ion mode. Which of these is dominant depends on the relative densities of the two components, but in general the light-ion mode becomes important for surprisingly small light-ion contamination. Approximate analytic expressions are derived for damping rates and phase velocities and their domains of validity are investigated. Relevance of the results for the investigation of collisionless shocks is discussed. (auth) (USGRDR)

45493 (COO-1695-34) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 17. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). 15 Jun 1971. Contract AT(11-1)-1695. 54p. Dep. NTIS.

Research was conducted for the following areas: (1) polarization measurements of the free-free bremsstrahlung x rays, (2) plasma kinetic theory, and (3) plasma diagnostics. The bremsstrahlung measurements were made to determine the polarization distribution of the free-free bremsstrahlung exciting radially along the midplane. The scattering method was used with beryllium as the scattering material. Use of this material, together with improved pulse-counting techniques resulted in a 5-fold increase in the scattered x-ray flux, necessitating counting times of only 200 to 400 minutes. Theoretical work was concentrated on a direct evaluation of the scattering matrix elements to obtain a definitive measure of the anisotropy of the free-free bremsstrahlung, a more definite statement on the nature of distribution functions that can be used to describe the plasma. A method for determining the amounts of cold and hot plasma present in the device is being developed. The method is based on a different response to microwaves in a cavity when the plasma is considered warm than when it is cold. (M.O.W.)

45494 (ORNL-4688, pp 1-23) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

Work on each of the following is briefly described: (1) linear stability theory of mirror-confined plasmas, (2) nonlinear evolution of "double-hump" instabilities, (3) static MHD equilibria of high-beta plasmas in Tokamaks, (4) time-dependent heat flow and current diffusion in Tokamaks, (5) MHD stability of Tokamak discharges, (6) single-particle drifts of fast particles injected into ORMAK and their energy exchange with background plasma particles, (7) neoclassical diffusion in Tokamaks and Bumpy Toruses, (8) hot-electron equilibrium in the canted-mirror experiments, and (9) other less programmatic areas of general interest. (M.O.W.)

45495 (UCRL-51059) NONLINEAR INTERACTIONS IN SIMULATED PLASMAS. Smith, Janet Lee (California Univ., Livermore. Lawrence Radiation Lab.). Jul 1971. Contract W-7405-eng-48. 116p. Dep. NTIS.

Thesis.

Nonlinear instabilities arising from the interaction of positive and negative energy waves in a plasma were observed on a 1-D superparticle computer model. In particular, nonlinear resonant three-wave interactions and nonlinear two-wave-particle interactions were investigated for linearly stable plasmas with regard to situations that are theoretically explosively unstable. The results of these computer experiments were correlated with existing theoretical predictions in order to check various aspects of the theory. In most cases, the experimental results agreed well with the available theories up to the time of saturation. Saturation is observed when the electrostatic energy grows to about 1% of the kinetic energy in the system, sufficient to cause significantly large changes in the equilibrium orbits. Several plasma configurations capable of supporting both positive and negative energy waves were investigated but, for most systems, competing stabilizing resonances dominated the explosive instabilities. Nonlinear explosive instabilities were clearly demonstrated for perpendicularly propagating, linearly stable cyclotron waves in a plasma with a delta-function velocity distribution. The occurrence of such nonlinear instabilities requires precise resonance as well as freedom from competing stabilizing resonances. In general, the results favor the prediction that such nonlinear instabilities would occur experimentally only if the level of the unstable resonant modes was pumped up well above the level of competing resonances. (auth)

45496 DRIFT INSTABILITY IN THE PRESENCE OF NONUNIFORM RADIAL ELECTRIC FIELDS. Capjack, C. E.; Stringer, T. E. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: No. 12, 1630-40(15 Jun 1971).

An equation describing the drift instability in a collisionless low-β plasma, in the presence of a nonuniform radial electric field is derived from guiding center equations for the ions and the drift kinetic equation for the electrons. Numerical solutions to this equation indicate that the influence of a nonuniform radial electric field on the drift instability may be determined from the manner in which this field modifies the macroscopic electron rotation profile. (auth) (Canada)

45497 THEORETICAL STUDY OF THE INSTABILITIES OF FINITE-BETA PLASMAS IN THE TOROIDAL MULTIPOLES. Kim, In Kyu. Madison, Wis.; Univ. of Wisconsin (1971). 158p. University Microfilms Order No. 71-9179.

Thesis.

The general theory of microinstabilities of an inhomogeneous plasma in an axisymmetric torus is extended to include magnetic perturbations. Temperature gradients are also included in the theory, but the magnetic shear is neglected. The Vlasov and Maxwell equations are solved self-consistently by using a perturbation method, where characteristic frequencies of the oscillations are small compared with the ion gyrofrequency. The results are applied to the multipole configurations and various modes of wave excitations are critically examined in the light of the finite-β effects. Here, β is the ratio of plasma to magnetic pressures. In the high-frequency region $\omega > \omega_{be} > \omega_{bi}$, where ω_b's are the particle orbit frequencies, instabilities are suppressed by the average favorable curvature (i.e., negative V''), and finite β tends to stabilize the modes. In the low-frequency region $\omega < \omega_{bi} < \omega_{be}$, the finite β does not affect any modes unless $\beta \sim 1$, which is outside the range of validity of the theory. In the intermediate-frequency region $\omega_{be} > \omega > \omega_{bi}$, instabilities for long perpendicular wavelengths (drift ballooning and universal modes) are enhanced by finite-β effects when $\beta \gtrsim r_N/L_0^2$, where L_0 is the connection length and r_N is the scale length of density variation. For short perpendicular wavelength the fluid-like electron drift instability is suppressed by the finite-β effect, which is conspicuous when the above condition on β is also satisfied. For the present-day multipole configurations, $r_N \simeq 1$ cm, $L_0 \simeq 10$ cm, and the finite-β effects will be important when $\beta \gtrsim 10^{-2}$, which happens to be the range of β for which the fusion reaction can be achieved. The finite-β effects are negligible for the present-day multipole experiments, in which plasma density and temperature are so low that $\beta \lesssim 10^{-5}$. Instabilities are enhanced by the temperature gradient, which is in the opposite direction to the density gradient. This effect is conspicuous when the scale length of the temperature variation is comparable to, or greater than, the scale length of the density variation. (Diss. Abstr. Int., B)

45498 ELECTROSTATIC OSCILLATIONS OF AN INHOMOGENEOUS PLASMA. Lindgren, Nathan Edward. Berkeley, Calif.; Univ. of California (1970). 112p. University Microfilms Order No. 71-15,825.

Thesis.

Magnetically confined plasmas with density gradient perpendicular to the magnetic field are subject to a number of unstable waves having the property that the wave electric field is parallel to the direction of propagation. Such waves are studied experimentally in a low-density, low-temperature, mirror-magnetic field confined potassium plasma (which simulates many of the properties of high-temperature, high-density, fusion plasmas) and numerically through computer solutions of the dispersion relation. An oscillation is observed that has many of the properties of the gravitation-like centrifugal instability. Radial electric fields present in the plasma cause an $E_r \times B$ rotation of the plasma with velocity several times larger than the diamagnetic velocity. The resultant centrifugal force can cause a growing electrostatic oscillation of the plasma. By applying an external electric field to oppose the natural electric field, the plasma rotation can be made to stop and the oscillation to vanish. A sufficiently strong applied electric field causes the waves to reappear when the plasma rotation direction has been reversed. The two directions of rotation are found to have different threshold values of electric field for the unstable waves to occur, which is in qualitative agreement with theory which includes the Coriolis force. Simultaneous suppression of several unstable drift wave–centrifugal modes in a collisionless plasma was achieved using several independent feedback systems, each one tuned to a different mode. This is an improvement over broadband systems in which suppression of one mode has generally led to enhancement of other modes. An oscillation with frequency greater than the ion cyclotron frequency is observed. Data are presented to show that the oscillation may be unstable due to the interaction of the wave and electrons streaming along the magnetic field in such a way that $\partial f_e / \partial v_{||} > 0$ at $v_{||} = \omega/k_{||}$, where $f_e(v_{||})$ is the distribution of electron velocities along the magnetic field, B, and $\omega/k_{||}$ is the wave phase velocity parallel to B. The dispersion relation for small-amplitude electrostatic waves in an inhomogeneous plasma is solved numerically for several classes of ion perpendicular (to B) velocity distributions. For $k_{||} = 0$, the ion drift-cyclotron instability, the velocity space instability of Dory, Guest, and Harris, and a wave with the unusual feature that the frequency varies inversely with density gradient are examined. The effects of $k_{||} \neq 0$, tending to stabilize the drift-cyclotron instability and destabilize the electron drift wave, ion acoustic wave, and the "inverse gradient wave," are also studied. (Diss. Abstr. Int., B)

45499 CURVATURE STABILIZATION OF THE UNIVERSAL INSTABILITY. Emmert, Gilbert A. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 42: No. 9, 3530-1(Aug 1971).

A graphical technique for determining the influence of the drift velocity in a magnetic well on wave–particle resonance is presented and applied to the universal instability. It is seen that the curvature drift velocity can strongly affect the number of resonant ions and lead to increased stabilization of the wave. (auth)

45500 NONLINEAR DEVELOPMENT OF THE BEAM–CYCLOTRON INSTABILITY. Lampe, M.; Manheimer, W. M.; McBride, J. B.; (and others) (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 26: No. 20, 1221-5(17 May 1971).

A theory is presented for the nonlinear evolution of the beam-cyclotron instability, together with the results of a series of computer experiments confirming the main points of the theory. It is concluded that at a turbulent level, which is proportional to $(\Omega_{ce}/\omega_{pe})^2$, a transition is made to the nonmagnetic ion acoustic instability. For small T_i/T_e, the system then evolves until the fluctuating fields become strong enough to stabilize by ion trapping. (auth)

45501 EQUILIBRIUM AND STABILITY OF CYLINDRICAL LINEAR PINCH WITH HOMOGENEOUS TEMPERATURE. Aleksandrov, A. F.; Kaminskaya, E. P.; Rukhadze, A. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 33-9(Jan-Feb 1971). (In Russian).

Equilibrium and stability of high-current discharges in dense optically grey plasma are studied theoretically. The plasma is considered completely opaque for long-wave quanta and completely transparent for short-wave quanta. The value of limiting frequency was determined for the equivalence of dimensions of the plasma jet and the quantum mean free path. MHD equations are resolved, together with the radiative transfer equation. It is shown that in grey plasma the existence of the equilibrium state is possible with practically homogeneous distribution of temperature along the discharge cross section. The homogeneity of temperature is provided by larger radiative thermal conductivity, which was associated with long-wave radiation. Radiative thermal conductivity also determines the stability of the discharge in relation to overheating. The possibility of using such a discharge for energetic laser pumping is analyzed. It was found that, for discharge currents of the order of 10^6 A, grey discharge efficiency is three times greater than that of the opaque discharge. (tr-auth)

45502 POSSIBILITY OF SUPPRESSING IONIZATION INSTABILITY OF A MAGNETIZED WEAKLY IONIZED NONISOTHERMAL PLASMA BY MEANS OF A SYSTEM OF FEEDBACKS. Arsenin, V. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 6, 1202-4(Nov-Dec 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 6, 1285-6(Nov-Dec 1970).

A current-carrying weakly ionized plasma in a uniform magnetic field was investigated. Its two-dimensional electrostatic quasi-neutral oscillations are studied, assuming that thermal conductivity may be neglected, the electron temperature is much higher than the temperature of the heavy particles, and local ionization equilibrium occurs at each instance. Stability conditions are described. (M.O.W.)

Thermonuclear Processes

Refer also to abstract 46044.

45503 (LA–4709) FACILITY FOR DUPLICATING 14-MeV NEUTRON EFFECTS IN FUSION POWER REACTORS. Dreicer, H.; Henderson, D. B. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 4p. Dep. NTIS.

The study of the neutron effects that will occur in a controlled fusion reactor requires a 14-MeV neutron flux one thousand times larger than presently available. This interim report describes a practical means for achieving such a flux. (auth)

45504 (MATT–842) LEVITATED RING IN FM-1. Willard, J. W.; File, J.; Martin, G. D. (Princeton Univ., N. J. Plasma Physics Lab.). Jul 1971. Contract AT(30-1)-1238. 9p. (CONF-710418–19). Dep. NTIS.

From fourth symposium on engineering problems of fusion research; Washington, D. C. (20 Apr 1971).

The design and tests of the 60-inch-diameter superconducting ring and Dewar assembly are described. The ring was successfully levitated in the slide unstable mode in the FM-1 Machine. The magnet, wound of 4221 turns of 90-mil RCA Nb_3Sn ribbon, has a current capacity of 375,000 ampere turns. The coil is charged inductively or by external power supply, and is housed in a seven-inch-minor-diameter toroidal Dewar with external connections for filling, venting, and charging under high vacuum. Test results of quench temperature vs. current for isochoric life of the ring at full current is approximately one hour. This corresponds to 10.7°K at 25 atmospheres. (auth)

45505 (MATT–843) RING CATCHERS IN FM-1. Willard, J. W. (Princeton Univ., N. J. Plasma Physics Lab.). May 1971. Contract AT(30-1)-1238. 10p. (CONF-710418–20). Dep. NTIS.

From fourth symposium on engineering problems of fusion research; Washington, D. C. (20 Apr 1971).

The system for positioning and arresting the poloidal field coil in the FM-1 machine is described. The ring is held in the proper position, on centerline of the machine, by four positioner assemblies. Rotation of the ring to proper azimuth for filling, venting, and charging is provided. The positioner assemblies are lowered to the vacuum vessel floor during ring levitation or for ring maintenance. In the event of a system failure, resulting in loss of ring stabilization, the ring must be quickly arrested to prevent damage to the Dewar or machine. Four scissors-type mechanisms are positioned in the vacuum vessel for this purpose. A cylinder-mounted solenoid poppet valve is fired by a capacitor bank resulting in a signal to closure time of 60 msec. A slow-mode catch may also be actuated, through externally mounted valves, resulting in a cycle time of 150 to 200 msec. Upon closure and contact with the ring, the ring energy is absorbed by uncoupled slide and tilt spring systems. After a catcher closure cycle the positioners are again inserted and the ring returned to the proper position. (auth)

45506 (MATT–847) MACHINE FOR ADIABATIC TOROIDAL COMPRESSION. Christensen, U. R.; Citrolo, J. C.; Murray, J. G.; Wakefield, K. E. (Princeton Univ., N. J. Plasma Physics Lab.). May 1971. Contract AT(30-1)-1238. 7p. (CONF-710418–16). Dep. NTIS.

From fourth symposium on engineering problems of fusion research; Washington, D. C. (20 Apr 1971).

The Adiabatic Toroidal Compressor (ATC) is being built to investigate the feasibility of a proposed technique for increasing the density and ion temperature of conventional tokamaks. By applying a suitable magnetic field normal to the plane of a usual tokamak discharge, the major radius is caused to shrink to about 0.4 of its original value, thereby resulting in an increase both in temperature and density. A description of the device is given. (M.O.W.)

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45507 (ORNL–4688, pp 44-66) ORMAK PROGRAM. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

A description is given of the design and construction of the ORMAK 1. Ohmic plasma heating and injection heating in ORMAK are described. Diagnostic plans are outlined along with future areas of study. (M.O.W.)

45508 (ORNL–4688, pp 110-21) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

The principal endeavor of the group during this year has been to complete the superconducting coils for the IMP facility. This required extensive testing of the Nb_3Sn ribbon conductor in short sample and in "cusp coils" along with tests on insulation and high purity aluminum in order to determine an effective method to overcome the instability exhibited when the magnetic field perpendicular to the face of the ribbon ranged between 20 and 35 kG. The adopted solution, to interleave 6 mil high purity aluminum ribbon with the superconductor ribbon, proved satisfactory in that the coil system was successfully tested to 62% of the design current density. Further testing at fields up to the design value has been delayed until an initial series of plasma experiments has been completed at the lower fields. Other tasks associated with the IMP facility, the design of energy dumps, and cryogenic instrumentation and the fabrication of thin film for diagnostic devices, were also completed. Basic studies in superconductivity were not neglected in that studies were continued on the field and temperature dependence of the critical current and flux flow resistivity of a number of NbTi compositions, on the peak effect and pinning forces in NbTi alloys, on magnetization measurements with NbTi, and on the design of metastable magnets. The vacuum coating apparatus was used to deposit a gold surface on the ORMAK plasma containment wall to improve the outgassing during operation. Studies of thin film deposition were continued. (auth)

45509 (ORNL–4688, pp 122-6) FUSION REACTOR TECHNOLOGY. (Oak Ridge National Lab., Tenn.).

In Thermonuclear Division annual progress report.

The ultimate goal of the Controlled Thermonuclear Research (CTR) program is to develop a long-term energy source that would be not only economically competitive with alternate energy sources but also environmentally more desirable. In support of this goal the Thermonuclear Division has for the past two years been involved in a program of fusion reactor technology (FRT) studies. The objective of these studies has been to investigate those problems that must be solved in order to (1) demonstrate the technical feasibility of power by fusion and (2) ensure that the environmental insults of fusion power are minimal. Contributions in the following areas are briefly described: (1) environmental impact of fusion, (2) radiation damage, (3) magnet system design, (4) tritium breeding and recovery, (5) energy conversion, (6) inertial confinement, and (7) alternate fuel cycles. (auth)

45510 (ORNL-TM–3472) MULTI-AMPERE DUOPIGATRON ION SOURCE FOR PLASMA RESEARCH. Davis, R. C.; Morgan, O. B.; Stewart, L. D.; Stirling, W. L.; Forsen, H. K. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 23p. Dep. NTIS.

A source was constructed that consists of a duoplasmatron ion source feeding a PIG discharge system. The extraction electrodes are multi-aperture and are arranged in an accel–decel arrangement with a 5-cm diameter. The source is simple, flexible and efficient. Beams of 1A are extracted in steady-state operation with ion energies of from 1.5 to 5 keV. Beams of 4A are extracted for 0.1-sec pulses and 10% duty cycle at ion energies of 20 to 40 keV. At 30 to 40 keV ≈ 60% of the ion beam is within a half angular divergence of 1.2° with no magnetic lens. Using a hydrogen gas cell this system produces 2.6 A (equivalent) of 17.5- and 35-keV H^0 particles within a half angular divergence of 1.2°. One of the present limitations in scaling the source to larger beams is the current capabilities of the power supplies. As larger supplies are available attempts will be made to scale this system to the 10-A beam modules needed for future fusion research. (auth)

Wave Phenomena

45511 (AD–719764) CONSIDERATIONS FOR NONLINEAR MICROWAVE BREAKDOWN AND PROPAGATION. Fante, Ronald L. (Avco Corp., Wilmington, Mass. Avco Systems Div.). 15 Jan 1971. Contract F19628-69-C-0121. 34p. (AFCRL–71-23). NTIS.

Approximations were considered that lead to a simplified model for nonlinear microwave breakdown. Using the simplified model, the propagation of a high-power plane wave into a steady-state (partial derivative of n with respect to t = 0) gaseous half-space was considered. Numerical results are presented for the nonsteady-state case ($\partial n/\partial t \neq 0$). (auth) (USGRDR)

45512 (SU-IPR–411) STUDIES OF PLASMA OSCILLATIONS. Final Report. Status Report No. 37. (Stanford Univ., Calif. Inst. for Plasma Research). Feb 1971. Contract AT(04-3)-799. 44p. Dep. NTIS.

The historical development of the research program as it progressed through three phases is discussed. The first may be regarded as a passive "anatomical" one in which the basic hot-cathode positive column discharge was examined by a number of techniques to pinpoint the sources of oscillations and instabilities in it and to determine their excitation mechanisms. It was soon followed by a transition to a more active phase in which specific phenomena, such as beam/plasma interaction and ion acoustic wave propagation, were studied by probing suitable plasmas with externally applied signals, and serious attempts were made by analysis and measurement to reduce the discrepancies between theory and experiment. It merged eventually into the present phase, in which a wide variety of plasma wave and instability phenomena were examined in detail. The research program, bibliography of reports, conference papers, and publications prepared under the contract, are listed. (auth)

45513 PARAMETRIC COUPLING OF LIGHT WAVES IN A PLASMA. Aslaksen, Erik W. (Brown Boveri Research Center, Baden, Switzerland). Z. Angew. Math. Phys.; 22: No. 3, 442-57(25 May 1971).

A brief theoretical analysis of plasma waves is presented. Cases for single exciting and two exciting fields are described. Parametric amplification of the waves is discussed. (M.O.W.)

45514 SIMPLE WAVES IN COLLISIONLESS INTERPLANETARY PLASMA GOVERNED BY CHEW–GOLDBERGER–LOW EQUATIONS. Sielawa, Jerzy Tadeusz. Ann Arbor, Mich.; Univ. of Michigan (1970). 294p. University Microfilms Order No. 71-15,307.

Thesis.

The propagation of simple waves in collisionless plasma with anisotropic pressure (as found in interplanetary space) is studied. The plasma is assumed to obey the modified Lundquist system of equations, resulting from the Chew–Goldberger–Low (C.G.L.) equations. Physical properties of all wave modes are discussed and some special cases are singled out (wave movement aligned with magnetic field; wave movement perpendicular to magnetic field; wave movement in strong magnetic field). The particular problem of steepening of simple waves is stressed and the conditions under which such steepening occurs are discussed. Ranges of physical parameters are determined for which either condensation ($\Delta\rho > 0$) or rarefaction ($\Delta\rho < 0$) shock waves are formed, through the steepening process, out of simple waves in a medium obeying C.G.L. equations. (Diss. Abstr. Int., B)

45515 OSCILLATIONS OF INHOMOGENEOUS FLOWS OF PLASMA AND FLUIDS. Timofeev, A. V. (Inst. of Atomic Energy, Moscow). Usp. Fiz. Nauk; 102: 185-210(Oct 1970). (In Russian).

The stability and oscillations of inhomogeneous flow of plasma and normal fluids are considered from the point of view of new physical concepts in plasma theory. Examined are oscillations of plane-parallel flows of normal fluids, flute oscillations of rarefied noncompensated plasma in magnetic fields, the oscillations of electron currents in longitudinal magnetic fields, and flute oscillations in quasi-neutral plasmas in magnetic fields. It was found that flows with the simplest velocity profiles are stable. Methods for investigating the resonant interaction of oscillations with moving continuous media can be used to adequately describe the order of similar physical phenomena in quiescent plasma, e.g.: cyclotron absorption of electromagnetic oscillations in inhomogeneous magnetic fields, stabilization of cyclotron oscillations of nonequilibrium plasma in inhomogeneous magnetic fields, and transformation of waves in inhomogeneous plasma. (tr-auth)

45516 LOSS-CONE INSTABILITIES IN THE FIELD OF THE HELICON WAVE. Teichmann, J. (CEN, Grenoble, France). Phys. Lett.; 36A: No. 1, 19-20(2 Aug 1971).

Dielectric properties of plasma penetrated by the helicon wave are established. The stabilization of loss-cone instabilities is discussed. (auth)

45517 SPATIALLY DAMPED TEMPERATURE OSCILLATIONS IN A HIGHLY IONIZED PLASMA COLUMN. Stefanov, B. (Princeton Univ., N. J.). J. Appl. Phys.; 42: No. 9, 3540-4(Aug 1971).

A time-varying heat flow along a highly ionized plasma column

is analyzed theoretically. The diffusion of a locally applied sine-wave temperature disturbance for frequencies up to 10^6 Hz is shown to be accompanied by a potential disturbance of the same phase, other quantities (such as density, velocity, and ion temperature) having different phase angles and much smaller amplitudes than the electron temperature and the potential. Calculations of the phase lag of the temperature wave along the column are presented and compared with measurements in a highly ionized cesium plasma column for frequencies 10^2 to 10^4 Hz. The measured thermal diffusivity coefficient determining the phase lag agrees with theory within 20%. (auth)

45518 COLLISIONLESS HEAT WAVES IN PLASMA. Ivanov, A. A.; Istomin, Ya. N.; Kozorovitskii, L. L.; Rusanov, V. D. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 51-9(Jan-Feb 1971). (In Russian).

Experiments on collisionless propagation of heat in plasma along magnetic fields are described. It was shown that heat is circulated along the magnetic field with a velocity that exceeds the ion acoustic velocity, and the spatial width of thermal perturbation is much less than the mean free path. Noises were discovered in the vicinity of the ion plasma frequency and their intensities were appraised. Theoretical investigations showed that ion acoustic instability developing on the wave front leads to the appearance of collective friction of cold electrons on ions and allows the effective collision frequency to be found. (tr-auth)

Shielding

Refer also to abstracts 44804, 45538, 45845, 46048, 46250–46252, 46308, and 46310.

45519 (AD-718865) SPECTRAL PROPERTIES OF THE LINEAR BOLTZMANN OPERATOR. Final Technical Report, December 1969–March 1970. Hejtmanek, H. J. Jun 1970. Contract DAJA37-70-C-0608. 35p. (ARDG(E)-E-1290(3)). NTIS.

The linear Boltzmann operator describing multiple scattering processes in electron and neutron transport theory is studied for a compact and convex system embedded into vacuum. The multiple time-dependent scattering process is completely described by the linear Boltzmann equation which is considered as an abstract Cauchy problem in time-dependent perturbation theory. The function space used is the Banach L^1. For two transport systems, multiple scattering in R^3 and diffusion in a compact reactor $R \approx R^3$, the spectrum and the resolvent set of the linear Boltzmann operator are given. The Hille–Yoshida condition for the existence of a unique solution, a semigroup of class (C^0), is given. (USGRDR)

45520 (COO-2060-14) APPLICATIONS OF THE TRANSMISSION MATRIX TO RADIATION SHIELDING. Progress Report, March 15, 1971–June 15, 1971. Rohach, Alfred F. (Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.). Contract AT(11-1)-2060. 9p. Dep. NTIS.

Several types of problems have been solved using the matrix kernel, namely: (1) the gamma-ray current density through a slab of homogeneous material either as a finite slab (no source backing and no outer boundary reflection), as a semi-infinite slab (no source backing), or as an infinite slab (source backing and outer boundary reflection); (2) gamma-ray current density from a point isotropic source for these conditions; (3) integration of the kernel from the transmission operator in the asymptotic condition over finite plane sources; (4) point isotropic sources shielded by layered slabs; and (5) the secondary-source gamma-ray problem. (M.H.R.)

45521 (LA-DC-12468) X-RAY SPECTRAL DISTRIBUTIONS FROM THICK TUNGSTEN TARGETS IN THE ENERGY RANGE 12 TO 300 kV. Storm, Ellery; Israel, Harvey I.; Lier, Douglas W. (Los Alamos Scientific Lab., N. Mex.). [1971]. 13p. (CONF-710802-2). Dep. NTIS.

From twentieth annual conference on applications of x-ray analysis; Denver, Colo. (11 Aug 1971).

Bremsstrahlung emission from four x-ray tubes operating at 12 to 300 kV was measured. Spectral distributions are given in terms of absolute-photon and energy fluxes. Silicon and germanium semiconductors, sodium iodide scintillators, and a xenon proportional counter were used to measure the spectra. Detector distortions were corrected by assuming an undistorted spectrum, distorting the spectrum with a Monte Carlo computer program, and comparing the results with measurement. The assumed undistorted spectrum was revised until the Monte Carlo calculation gave satisfactory agreement with spectral measurements from all four types of detectors. The effects on the spectra of varying the tube potential, tube current, target aperture, and detector aperture were investigated. Corrections for the intervening material and the solid angle subtended by the detector were applied to obtain the absolute-photon and energy flux from the target. Total fluxes in the L lines, K lines, and continuum are given. X-ray-production efficiencies varied from 0.026% at 12 kV to 1% at 300 kV. The constant of proportionality varied in the range $(0.23 \text{ to } 0.73) \times 10^{-6}\ \text{kV}^{-1}$. (auth)

45522 (ORNL-tr-2465) PROGRAM OF DOSE CALCULATION. Brettes, J.; Philippon, J. P. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from pp 139-64 of Calcul des Doses de Radiations dans l'Espace, Toulouse, France, February 21–23, 1968. Elbaz, C.; Faugere, J. F.; Lebeau, A. (eds.). Toulouse; Comptes Rendus des Journees Europeennes (1968). 19p. (CONF-680219-1). Dep. NTIS.

Knowing the orbital parameters, a method is proposed for calculating the dose of electrons and protons received by a satellite in one or several revolutions. This calculation is broken down into three stages, the calculation of orbit, the conversion of geographic coordinates into (B, L) coordinates, and the calculation of the dose received. Where the transformation of the geographic coordinates into (B, L) coordinates is concerned, two methods are discussed: the conventional method used by McIlwain and an approximate method called the "perturbations method" whose precision, however, is sufficient for most cases, while permitting a considerable gain in calculating time. (auth)

45523 WHAT IS ENERGY IMPARTED. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 2, 317-21(Aug 1971).

The purpose of this investigation was to clarify the formulation of a quantity known as "energy imparted" which represents the energy removed from a radiation field but not including that given to increase rest mass. It is pointed out that by not taking into account the energy of ionizing particles within a volume element in matter, energy imparted has not been, in the current ICRU recommendations, rigorously defined. An attempt is made to reformulate energy imparted and related dosimetric quantities in a rigorous manner within the framework of a macroscopic field theory. (auth) (UK)

45524 SHIELDING EFFECTIVENESS OF MAGNETITE HEAVY CONCRETE ON ^{60}Co GAMMA-RAYS. Lim, Yong Kyu (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 3: No. 2, 65-75(Jun 1971).

The gamma-ray shielding effects of magnetite concretes were measured using a broad-beam ^{60}Co gamma source. Mathematical formulas for a transmission ratio-to-shield thickness relation were derived from the attenuation curve obtained experimentally and are $I_{(X)} = I_{(0)} \exp(-\mu X) \exp(1.03 \times 10^{-1} X - 3.38 \times 10^{-3} X^2 + 5.29 \times 10^{-5} X^3)$ when $X < 20$ cm; and $I_{(X)} = I_{(0)} \exp(-\mu X) \exp(4.66 \times 10^{-2} X + 2.12 \times 10^{-1})$, when $X > 20$ cm. Here $I_{(X)}$ is the radiation intensity after passing through a thickness X of absorber, $I_{(0)}$ is the initial radiation intensity, μ is the linear attenuation coefficient of magnetite concrete and is given by $(0.0532\rho + 0.0083)^4\ \text{cm}^{-1}$ in accordance with an earlier study, and X is the thickness of absorber. In addition, a model shield which is a rectangular magnetite concrete box with walls of 8-cm thickness and internal dimensions of $40 \times 40 \times 40$ cm was constructed and its shielding effect was measured. The emergent radiation flux appears to be greater with this configuration than with a slab shield of equal thickness. (auth)

45525 PENETRATION OF 24.8 MeV ELECTRONS THROUGH THICK LAYERS. I. ENERGY LOSS AND STRAGGLING OF 24.8 MeV ELECTRONS IN THICK LAYERS OF C, Al, Cu, AND Pb. Tomimasu, Takio; Mikado, Tomohisa; Tsuchiya, Yoshio; Sugiyama, Suguru; Chiwaki, Mitsukuni. Denki Shikensho Iho; 35: No. 1, 92-105(1971). (In Japanese).

Systematic measurements of the energy loss and straggling of 24.8-MeV electrons (about 0.4% in energy width) were conducted in C, Al, Cu and Pb absorbers of thicknesses between 0.18 and 8.82 g/cm^2 using a magnetic spectrometer of high resolution (0.1%). The experimental values of the most probable energy losses agree with available calculations for C and Al absorbers of thicknesses to 8.82 g/cm^2 and for Cu and Pb of thicknesses below 3 g/cm^2 while they are larger by 5% than the calculations for Cu and Pb of thicknesses larger than 3 g/cm^2. Energy straggling is not yet describable by available calculations, especially for light materials. The half widths are systematically larger by 10 ~ 20% than the values calculated by Blunck and Westphal. Atomic number dependence of the half widths is also discussed concerning absorbers of 0.5, 1 and 2 g/cm^2. Increases in low energy components of the straggling distributions were also observed for thick C, Al, Cu and Pb absorbers. (auth)

45526 MEASUREMENTS OF SCATTERED GAMMA-RAYS. ^{192}Ir GAMMA-RAYS SCATTERED IN THE IRON PLATE. Tsujimoto, Tadashi; Katsurayama, Kosuke (Kyoto Univ.). Hihakai Kensa; 20: No. 3, 127-33(Mar 1971). (In Japanese).

XUM

The energy and angular distributions of the scattered gamma rays were measured with iron plates of 5, 10, 20, and 30 mm in thickness. A collimated source of ^{192}Ir was used, whose spectrum had main components at 310, 470 and 600 keV. The detector used was a NaI(Tl) scintillation counter being connected with a 400-channel pulse-height analyzer. The response function of the detector was experimentally determined from the measurements of several monochromatic gamma rays. Main results are as follows: as the thickness of the iron scatter increases, the dose of the scattered ray increases rapidly at first and attains the maximum at 12 ~ 13 mm in thickness; then, the directly transmitted dose decreases monotonously. The angular distributions of scattered rays have peaks at 16° and 22° for the iron plates of 20 and 30 mm in thickness, respectively, and decrease rapidly at larger angles. (auth) (Japan)

45527 TRANSPORT CALCULATIONS IN PARTICLE-LOADED MEDIA. Scrivner, Gary Jo. Albuquerque, N. Mex.; Univ. of New Mexico (1970). 108p. University Microfilms Order No. 71-12,796.

Thesis.

Particle-loaded materials are sometimes used for radiation shielding. In many cases, shielding calculations performed with the assumption of a homogeneous medium having the appropriate ratio of particle-to-matrix material are grossly inadequate. Two models of a particle-loaded shield are investigated. The first is an artificial material postulated to consist of constant-thickness slabs of infinite lateral extent, which are called "particles", randomly imbedded in a matrix material. Precise analytic results are obtained for the case in which particle and matrix are pure absorbers. The second is a more realistic model, consisting of constant-radius spheres randomly imbedded in a matrix material. A precise treatment of this model is extremely difficult; hence, the author examines two approximate schemes that are advantageous from a computational standpoint. The first approximate scheme has the characteristic that, in the limit of low volume-percent loadings, it approaches the rigorous solution. The second approximate scheme, valid when the first scheme is inadequate, provides a useful method of evaluating the behavior of highly loaded materials. Again, both particles and matrix are taken to be pure absorbers. The sphere-loaded problem is investigated by employing Monte Carlo procedures to construct simultaneously transport-particle histories and the structure of the medium encountered during these histories. For the pure absorption problem, it is found in both models that, for shields that are very thin relative to particle dimensions, the average transmission initially decreases in agreement with the homogeneous shield assumption. As the shield thickness increases, however, the average transmission can depart very quickly from the behavior one would calculate by assuming the shield to be a homogeneous mixture of particle and matrix material. This departure asymptotically results in an exponential behavior governed by an effective constant cross section, which is characteristic of the loaded shield and which is lower than the cross section associated with the homogeneous assumption. (TSS) (Diss. Abstr. Int., B)

45528 CARBON DESORPTION IN TaC AND THE CHARACTERISTIC ELECTRON ENERGY LOSS AS A FUNCTION OF SCATTERING ANGLE. Zashkvara, V. V.; Vlasenko, V. A.; Red'kin, V. S.; Korsunskii, M. I.; Chaikovskii, E. F. (Inst. of Nuclear Physics, Alma Ata, USSR. All-Union Single Crystals Research Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 132-5(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 166-71(Jan 1971).

Reflection of a 1-keV primary beam at scattering angles of 39 and 141° was used to examine the characteristic-loss spectra for tantalum carbide specimens close in composition to TaC and produced by prolonged heating of pure tantalum strip in benzene vapor. The specimens are heated to a high temperature during the reflection. A surface layer a few atoms thick is enriched in carbon, which tends to desorb during the heating, and the surface composition approaches pure tantalum. (auth)

45529 CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN THE RARE-EARTH METALS Ho, Er, Tu, AND Yb. Bakulin, E. A.; Balabanova, L. A.; Stepin, E. V.; Shcherbinina, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 189-91(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 241-4(Jan 1971).

The characteristic energy losses of electrons were measured in four rare-earth metals: Ho, Er, Tm, and Yb. The method used employed a 25-keV electron beam shot into thin films of the metals. The excitation energies of the plasma oscillations and the interband excitations were determined; in addition, the number of electrons participating in the plasma oscillations was found, which turned out to be 3 electrons/atom. Changes in the spectra of characteristic energy losses were observed as the films were heated by the electron beam. These changes were related to the oxidation of the metal films in a vacuum of about 10^{-5} mm Hg. (auth)

45530 BREMSSTRAHLUNG OF RELATIVISTIC ELECTRONS IN CRYSTALS. Komar, A. P.; Korobochko, Yu. S. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 192-7(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 245-51(Jan 1971).

A classical treatment of the mechanism of coherent effects in the process of emission of bremsstrahlung by electrons in crystals is presented. It is shown that in the case of emission from individual atomic chains in thin crystals, the obtained spectra are qualitatively the same (except in polarization) as in the ultra-relativistic energy range of primary electrons. Expressions for the coherent and noncoherent components of the spectrum can be given a form similar to the Schiff spectrum. The shape of coherent lines in the emission spectrum is discussed. (auth)

45531 TRANSITION RADIATION AND OPTICAL BREMSSTRAHLUNG FROM ELECTRON-IRRADIATED THIN FILMS OF GOLD, SILVER, AND COPPER. DiNardo, R. P.; Goland, A. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., B; 4: No. 6, 1700-8(15 Sep 1971).

The optical emission from electron-irradiated self-supported films (500 to 2000 Å thick ±10%) of gold, silver, and copper was investigated experimentally. Normally incident 1-μA beams of monoenergetic electrons having energies of 297, 423, 632 keV, and 1.10 MeV were used. The absolute photon intensity emitted in the spectral region 2200 to 5800 Å was measured with a calibrated optical system. The results were analyzed with respect to wavelength of emitted radiation, angular distribution in the forward direction (15°, 30°, and 45° from normal), and degree of polarization (parallel and perpendicular to the plane defined by the incident electrons and the emergent photons). The photon intensities measured in the perpendicular polarized direction clearly exhibit characteristics of bremsstrahlung. The transition-radiation contribution agrees very well with that predicted by the generalized theory of Ritchie and Eldridge when the bremsstrahlung is assumed to be unpolarized. From this, one may infer that interference between transition radiation and bremsstrahlung in the parallel plane does not grossly affect the emitted intensity. This investigation has extended the study of optical emission by Arakawa and coworkers to higher energies, thicker foils, and additional angles of emission. (auth)

45532 CALCULATION OF THE BULK BUILDUP FACTOR OF EXTENSIVE GAMMA SOURCES WITH ENERGY $E \leq 0.5$ MeV. Drozdov, V. E.; Dunaev, L. M.; Orlenko, N. I. Radiobiologiya; 11: No. 2, 304-6(Mar–Apr 1971). (In Russian).

In calculations of the accumulation factors of extensive sources, it is necessary to have an analytical expression for the buildup factor of a point isotope source. The coefficients α and A calculated by the method of least squares, for the calculation of the buildup factor from extensive sources with $E_\gamma \leq 0.5$ MeV are presented for water, aluminum, iron, and lead. (tr-auth)

Solid-State Physics

Radiation Effects

Refer also to abstracts 44745, 44746, 45166, 45295, 45860, and 45861.

45533 (AD-718433) RADIATION DAMAGE AND CHEMICAL REACTIONS INDUCED IN CRYSTALLINE SOLIDS BY HIGH-ENERGY PROTON BOMBARDMENT. Final Report, July 1, 1968-July 1, 1970. Zeller, Edward J.; Dreschhoff, Gisela; Virmani, Yash P.; Zimbrick, John (Kansas Univ., Lawrence. Dept. of Geology). 1 Sep 1970. Contract F19628-69-C-0009. 55p. (AFCRL-70-0594). NTIS.

The major portion of the work involved proton irradiation of solids using energy ranges from 0.7 to 2.5 MeV. Alpha particles and deuterons were also available and were used for special studies. In general, the results of the bombardments were evaluated with either electron spin resonance (ESR) or differential thermal analysis (DTA) techniques. The data provided by the ESR analytical methods tends to substantiate the conclusion that proton bombardment of diamond results in the formation of CH radicals. Furthermore, there is no doubt that H atoms can be trapped in the diamond lattice and will remain uncombined at liquid nitrogen temperature. (auth) (USGRDR)

45534 (AD-720197) PHOTOPRODUCTION OF DISORDER IN $Pb(N_3)_2$ AND TlN_3. Wiegand, D. A. (Picatinny Arsenal, Dover, N. J.). Dec 1970. 39p. (PA-TR-4080). NTIS.

Lead, thallium, and other inorganic azides were exposed to ultraviolet and x irradiation, and the resulting changes in optical properties were studied. This irradiation was found to produce a structureless increase in extinction, which increases in magnitude with decreasing wavelength to the band edge. Calculations for $Pb(N_3)_2$ indicate that the wavelength dependence of this irradiation-induced extinction is what might be expected from colloidal lead. The increased extinction is insensitive to the temperature of observation, and diffuse reflectance measurements indicate that some part, if not all of it, is due to absorption. Both of these results are to be expected if the extinction is due to colloidal lead. Essentially the same type of extinction is obtained for ultraviolet and x irradiation at sample temperatures of 12°, 78°, and about 300°K, and also for decomposition produced solely by thermal means. Some differences between $Pb(N_3)_2$ and TlN_3 are discussed. (auth) (USGRDR)

45535 (AD-720274) RESEARCH ON RADIATION EFFECTS IN SOLIDS. Final Report, January 1968–December 1970. (Parke Mathematical Labs., Inc., Carlisle, Mass.). Contract F19628-68-C-0188. 18p. (AFCRL-71-54). NTIS.

A complete list of publications issued under the contract and some specific recommendations for extension of the work are included. Contents include the following: theory of high-energy-induced low-energy secondary emission; theory of electron slowing down; energy deposition in cavities and near boundaries; and mathematical models of radiation damage in silicon. (USGRDR)

45536 (AD-720754) STRUCTURE, PROPERTIES, AND RADIATION SENSITIVITY OF ELECTRICALLY BISTABLE MATERIALS. Annual Report No. 1, February 6, 1970–February 6, 1971. Dove, Derek B.; Hench, Larry L.; Gould, Robert W.; Loehman, Ronald E. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Contract DAHC04-70-C-0024. 61p. NTIS.

A range of semiconductors of compositions Ge_xSe_{1-x} and Ge_xTe_{1-x} was prepared and examined by x-ray diffraction to verify the composition limits of the glass-forming regions reported by previous workers. Thin films were prepared by flash evaporation of crushed bulk compounds and subjected to rdf analysis and electron microscopy, and several structural models are compared. Studies on the crystallization kinetics of the glasses were carried out with particular reference to material composition. An interpretation of these initial experiments is given in terms of a possible structural model for the glasses. The importance of crystallite size on the fast-neutron damage threshold in heterogeneous amorphous semiconductors is emphasized, and the results of radiation experiments on vanadate glasses are discussed. (auth) (USGRDR)

45537 (AERE-R-6092) IMPROVED CALCULATIONS ON THE NUMBER OF DISPLACEMENTS PRODUCED IN IRON DURING FAST NEUTRON IRRADIATION. Nelson, R. S. (Atomic Energy Research Establishment, Harwell (England)). May 1969. 9p. Dep. NTIS (U. S. Sales Only).

The basic assumptions underlying the Kinchin and Pease model, for calculating the number of atoms initially displaced during irradiation, are discussed in the light of present-day knowledge. A revised model is proposed, which for iron suggests that the Kinchin and Pease result is about half an order of magnitude too large, even neglecting mutual annihilation within the collision cascade. (auth)

45538 (BMBW-FBK-70-28, pp 505-24) RANGE AND RETENTION STUDIES OF 40-KV IONS IN SOLIDS. Santry, D. C.; Sitter, C. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

From seventh international conference on electromagnetic isotope separators and the technique of their applications; Marburg, Germany (7 Sep 1970).

In Proceedings of the international conference on electromagnetic isotope separators and the techniques of their applications (1970).

Ion range measurements are reported for polycrystalline foils of tungsten and gold. Also studied was the effect of dose on the retention of the 40 keV implanted ions on the range measurements. (TSS)

45539 (UCRL-51048) MOBILITY OF RADIATIVELY INDUCED ELECTRONS IN QUARTZ. Ahrens, T. J. (California Univ., Livermore. Lawrence Radiation Lab.). 25 May 1971. Contract W-7405-eng-48. 20p. Dep. NTIS.

The thermodynamic properties and electronic mobility of quartz under the conditions of isochoric (constant volume) heating induced by radiative deposition are calculated, using thermodynamic data and theories of electron motion in ionic solids and intrinsic semiconductors. Initially, α-quartz transforms to β-quartz at 1200°K and 15 kbar and this phase, in turn, melts at ~2100°K and ~26 kbar upon isochoric heating. Although detailed adiabatic release paths are not calculated, Young and Alder's theory is used to calculate a critical temperature of $\sim 1.6 \times 10^4$°K and critical pressure of ~7 kbar for SiO_2. Assuming ionic bonding in quartz in both the liquid and solid state, and applying Fröhlich's theory of electron–phonon scattering, yields electron mobilities that are nearly constant below room temperature and vary as $T^{-\frac{1}{2}}$ above $\sim 3 \times 10^3$°K. A mobility of $\sim 2 \times 10^3$ (cm^2/V-cm) for 10-eV electrons, at room temperature, is obtained. The mobility value increases by 10^3 for each increase by a factor of 10^2 in electron energy. However, electron-hole pair production as a scattering mechanism at high energies is not considered. The intrinsic semiconduction model, applicable when electron temperatures are comparable to lattice temperatures, yields mobilities from ~20 to $\sim 2 \times 10^3$ (cm^2/V-cm) at 10^3°K. These values are comparable with values inferred from the ionic model. In treating quartz as an intrinsic semiconductor, the change in conduction band energy, with compression, is estimated, using the measurements of the change in band gap with pressure that have been carried out for a series of II–VI, IV, and III–V semiconductors. (auth)

45540 STUDIES OF ELECTRON–PHOTON SHOWERS IN LEAD GLASS. Aleksandrov, Yu. M.; Grushin, V. F.; Zinevich, A. N. Kratk. Soobshch. Fiz.; No. 12, 24-8(Dec 1970). (In Russian).

The basic properties of spatial development of showers in lead glass were studied, using a simple experimental method based on the ability of the glass to form specific and stable color centers under the effects of ionizing radiation. The number of color centers depends on the amount of absorbed radiation dose. Effects of 500-MeV electrons on the development of the shower in TF-1 glass and the distribution in a longitudinal direction of energy absorption from 10-, 17-, 25-, and 45-MeV electrons are discussed. It is also shown that the irradiated glass plates could be re-used many times following thermal treatment for 12 hr at 200°C after which the color centers disappeared and the original transparency was re-established. (R.V.J.)

45541 STUDIES ON NONMETALS DURING IRRADIATION. II. FORMATION AND POST-IRRADIATION GROWTH AND DECAY OF F CENTERS IN NaCl AT 20°C. Mattern, P. L.; Lengweiler, K.; Levy, P. W. (Brookhaven National Lab., Upton, N. Y.). Solid State Commun.; 9: No. 12, 935-9(15 Jun 1971).

Typical NaCl F-center growth curves measured during γ-ray irradiation at 20°C contain one linear and three saturating components. Following the termination of irradiation at low doses the coloring is constant, but at high doses, the curve contains one increasing saturating exponential, two decreasing exponentials, and one constant component. The resumption of irradiation after an interruption at low doses increases the coloring monotonically. At high doses, the resumption initiates a complex sequence of decreases and increases. (auth) (UK)

45542 ANNEALING PROCESSES IN n-TYPE Ge IRRADIATED WITH HIGH-ENERGY PROTONS. Konopleva, R. F.; Novikov, S. R.; Rubinova, E. E.; Sadikov, V. P.; Ukhin, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 8, 1296-1301(Feb 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 8, 1517-23 (Aug 1970).

The results are given of an investigation of high-temperature isochronous and isothermal annealing of n-type Ge irradiated with 660-MeV protons (10^{12} to 3×10^{14} protons/cm^2). It was found that n-type Ge crystals were annealed in two stages and p-type Ge samples (converted from n-type by proton irradiation) were annealed in three stages. The activation energy of the first stage (100 to 180°C) was ~0.72 eV for the p-type crystals. The second annealing stage (180 to 250°C) was characterized by activation energies of 1.3 eV for the p-type crystals and 1.5 eV for the n-type samples. The third stage (250 to 400°C) had an activation energy of ~2.4 eV. The results indicated that the defects generated by 660-MeV protons in the n-type Ge had a high thermal stability (~80% of these defects were annealed at temperatures above 250°C). An analysis was made of the data on the annealing kinetics of the defects generated in the n-type Ge by high-energy protons, fast neutrons, and γ rays. The basic differences found for the various radiations could be explained by the different relative contributions of the point and group defects to the radiation-induced changes in the properties of germanium. (auth)

45543 NEGATIVE DIFFERENTIAL RESISTANCE OF HIGH-PURITY GERMANIUM IRRADIATED WITH FAST NEUTRONS. Latyshev, A. V.; Stel'makh, V. F.; Tkachev, V. D.; Urenev, V. I. (Belorussian State Univ., Minsk). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 8, 1306-11(Feb 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 8, 1529-35(Aug 1970).

The results are given of an investigation of the electrical properties of high-purity germanium single crystals containing 2×10^{12} cm^{-3} donors and irradiated with fast reactor neutrons ($\Phi = 10^{11}$ to 10^{14} neutrons/cm^2). It was found that the current-voltage characteristics, recorded at 78°K for samples irradiated with $\Phi = 10^{12}$ to 9×10^{12} neutrons/cm^2, had negative differential resistance regions in the forward and reverse branches. The turnover fields were 30 to 150 V/cm, and these values were retained after the annealing of the samples up to 280 to 300°C. Annealing in the 125 to 160°C range revealed negative resistance regions in the characteristics of the germanium irradiated with $\Phi = 10^{13}$ neutrons/cm^2 (before annealing the characteristics of these samples were nearly linear). Measurements were made of the current–voltage characteristics and the Hall coefficient after isochronous and isothermal annealing and during illumination with light corresponding to the impurity and fundamental absorption regions. It was found that the nonlinear characteristics and the negative resistance were associated with the presence of a multidimensional structure of p–n microjunctions, which was the result of the formation of disordered regions by irradiation with fast neutrons. (auth)

45544 RECOMBINATION PROPERTIES OF n- AND p-TYPE GERMANIUM IRRADIATED WITH 660-MeV PROTONS. Evseev, V. A.; Konopleva, R. F.; Yuferev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 8, 1323-7(Feb 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 8, 1549-53(Aug 1970).

Carrier recombination in n- and p-type germanium irradiated with 660-MeV protons was studied. This was done by measuring the steady-state values of the photoconductivity and photomagnetic effect. It was found that the $E_c - 0.26$, $E_V + 0.30$, and $E_V + 0.20$ eV levels participated in the recombination of carriers in irradiated germanium. The cross sections for the capture of minority and majority carriers by these levels were determined and the temperature dependences of the cross sections were obtained. The value of the ratio of the capture cross sections ($\sigma_p / \sigma_n \sim 10^3$) indicated that the $E_V + 0.20$ and $E_V + 0.30$ eV levels were due to the same multiply charged centers but that the $E_c - 0.26$ eV level was due to different centers. The recombination properties of irradiated n-type germanium were described satisfactorily, at least in the first approximation, by the Shockley–Read statistics. However, even the statistics of recombination by multiply charged centers could not describe the recombination properties of irradiated p-type germanium. It was concluded that a more rigorous analysis of the recombination properties of germanium irradiated with 660-MeV protons would require an allowance for carrier recombination in disordered regions. (auth)

45545 BULK-GRADIENT γ-RAY INDUCED EMF IN p-TYPE Si. Dubovoi, V. K.; Konozenko, I. D.; Semenyuk, A. K. (Inst. of Physics, Kiev). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 8, 1349-50(Feb 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 8, 1575-6(Aug 1970).

Measurements of bulk-gradient emf's induced by illumination and ^{60}Co γ-ray irradiation were made on samples of p-type Si ($\rho_0 \approx 2000\ \Omega \cdot cm$) with longitudinal gradients of ρ. An ingot was grown along the [111] direction by the Czochralski method. After the distribution $\rho(x)$ had been measured, the ingot was cut into samples having considerable gradients of ρ of the same sign. Gold contacts were deposited on the ends of each sample. These contacts were nonrectifying in that range of temperatures T in which the measurements were carried out. The value of the γ-ray-induced emf was determined with the temperature of the sample held constant to within ±0.1°C. (M.O.W.)

45546 DOPING OF GALLIUM ARSENIDE BY THE IMPLANTATION OF ZINC IONS. Zelevinskaya, V. M.; Kachurin, G. A.; Pridachin, N. B.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 9, 1529-32(Mar 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 9, 1784-8(Sep 1970).

Properties of layers formed by the implantation of 30-keV zinc ions in semi-insulating and low-resistivity samples of n-type gallium arsenide were investigated. The implanted impurity was activated by brief annealing at 450 to 600°C. The effect of the annealing did not depend greatly on the dose (5 to 625 $\mu C/cm^2$) or on the substrate temperature during irradiation (25 to 500°C). Conducting layers were formed first at the surface and their depth increased as the annealing temperature rose. This depth also increased as dose was intensified. The conducting layers were found to be supersaturated with zinc ions to a considerable depth. It was assumed that the ion bombardment produced, in addition to known types of radiation defect, some large defect clusters whose dissociation at 450 to 600°C resulted in the generation of excess nonequilibrium vacancies. The presence of a large number of vacancies increased the solubility of zinc in gallium arsenide and slowed down its diffusion out of the doped layer. After the annealing, the electrical properties of the layers were similar in the semi-insulating and low-resistivity samples. The hole density was well correlated with the number of implanted zinc ions, right up to a dose of 5000 $\mu C/cm^2$. The mobility was not greatly affected by the dose. The depth of acceptor levels was close to zero. Planar p–n junctions, fabricated by the implantation of zinc in n-type GaAs, had a breakdown voltage of 35 V and a rectification coefficient of the order of 10^5 for a voltage of 1 V. (auth)

45547 RADIATION CONDUCTIVITY OF MANGANESE FERRITES. Dindun, S. S.; Raitman, E. A. (Inst. of Physics, Tashkent). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 25-8(1971). (In Russian).

Alterations in both specific electric conductivity and magnetic losses (angle tangent tg δ_M) of manganese ferrites of a series $Mn_xFe_{3-x}O_{4+\gamma}$ with $0.81 < x < 1.085$ and $-0.012 < \gamma < 0.001$ during γ irradiation were measured. It was established that in the low-temperature range, δ increases while tg δ_M practically does not change. The results can be explained by the different influence of γ radiation on rapid processes such as reorientation of local anisotropic configurations, i.e., the Mn^{3+} ion in octahedral environment which causes magnetic losses and diffusion processes bound with electric conductivity. (auth)

45548 NEW ABSORPTION BANDS IN FLUORITES BY HEAVY GAMMA IRRADIATION. Nambi, K. S. V.; Higashimura, T. (Kyoto Univ.). J. Phys., C (London); 4: No. 8, L134-6(14 Jun 1971).

At least three new bands were observed in the near-infrared region of the absorption spectra of fluorites of different origin after heavy γ irradiation in the range of 10^6 to 10^9 R. Studies were also made with a sample of synthetically pure CaF_2 crystal and the results indicate that the rare earth impurities abundantly present in the fluorites play an important role in the production of these new bands. The possibility of assigning these bands to some irradiation-produced colloidal centers in the fluorites is discussed. (auth) (UK)

45549 COLLOIDAL CENTERS IN IRRADIATED SODIUM CHLORIDE CRYSTALS. Pappu, S. V.; McCarthy, K. A. (Tufts Univ., Medford, Mass.). J. Phys. Chem. Solids; 32: No. 6, 1287-95(Jun 1971).

A systematic investigation of the formation and properties of colloidal centers in irradiated sodium chloride crystals was made, and the results are compared with published results on additively colored crystals. The main results and conclusions of this investigation are: (1) The colloid (designated as C_1 centers) evolution is not observed in a "lightly" irradiated (i.e. corresponding to the fast stage of the coloration process) and thermally bleached crystal; it is observed when a "heavily" irradiated (i.e. corresponding to the slow stage of the coloration process) crystal is thermally bleached at any temperature in the range 160 to 200°C. There is no evidence that the concentration of F centers per se has any influence on the C_1 center evolution. (2) The C_1 centers are found to be unstable under prolonged heating at any temperature in the range 160 to 200°C whereas in additively colored crystals they are stable up to about 250°C. The peak position of C_1 band is the same in both irradiated and additively colored crystals and it is about 560 nm. The half-width of C_1 band in irradiated crystals (about 0.5 eV) is larger than the half-width of C_1 band in additively colored crystals (about 0.18 to 0.32 eV). (3) The C_1 band in irradiated crystals is not affected by bleaching with either 560-nm light or F, M, R, N band peak light; it is affected, however, by white light and uv light. In contrast, the C_1 band in additively colored crystals is unaffected by any of the aforementioned light. (4) The presence of slow-stage F centers and the electron-hole recombination processes appears to play a significant role in the evolution of C_1 centers in irradiated crystals. (5) In view of the genetic relationship between F centers and C_1 centers, it is believed that the earlier proposed tentative mechanism for colloid evolution in additively colored crystals might be applicable in the case of colloid evolution in irradiated crystals. (auth) (UK)

45550 SCANNING ELECTRON MICROSCOPE STUDY OF THE DEGRADATION OF ELECTRON CHANNELLING EFFECTS IN ALKALI HALIDE CRYSTALS DURING ELECTRON IRRADIATION. Schulson, E. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Mater. Sci.; 6: No. 5, 377-83(May 1971).

The effects of in situ, 25-kV electron irradiation on SEM electron-channelling patterns from alkali halide crystals at room temperature are reported. Patterns were generated using wide- and narrow-beam methods. It is observed that after an initial period of irradiation, during which well-defined high-resolution patterns

can be generated, degradation occurs. This is marked either by channelling-line diffuseness or by waviness, depending on the method of generation. After prolonged irradiations, patterns can no longer be detected. Subsequent annealing experiments on irradiated NaCl show that patterns return to their original clarity if the annealing temperature is between 285 and 325°C. Initial distortions (i.e. diffuseness and waviness) are attributed principally to the effects on the incident beam of irradiation-induced surface electric fields; pattern loss, and subsequent recovery on annealing, is attributed to lattice distortion effects arising from beam-induced defect clusters. (auth) (UK)

45551 THERMOELECTRICAL PARAMETERS OF FAST-NEUTRON-IRRADIATED Te–Se–Bi, Te–Sb–Bi, AND GeSi. Macko, Pavel (Slovak Technical Univ., Bratislava). J. Phys. Chem. Solids; 32: No. 6, 1181-8(Jun 1971).

A review of measurement of electrical conductivity σ, Seebeck coefficient α, thermal conductivity λ and Z-parameter of semiconductor thermoelectric materials of Te–Se–Bi, Te–Sb–Bi, and GeSi, irradiated with fast neutrons with doses of $0\text{-}1\times10^{18}$ n' cm^{-2} is given. The experimental values are interpreted by relatively simple expressions. Negative as well as positive changes of investigated parameters were observed, which began to appear when the concentration of radiation defects N'_p was greater than the concentration of intrinsic defects N_{DO} before irradiation. (auth) (UK)

45552 EFFECT OF ELECTRIC FIELD DIRECTION ON PULSED RADIATION INDUCED CURRENT IN CRYSTALLINE QUARTZ. Okabe, S.; Tsumori, K.; Tabata, T.; Kawabata, K.; Yoshida, T. (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Appl. Phys.; 42: No. 9, 3545-7(Aug 1971).

Dependence upon sample orientation of the pulsed radiation-induced current (RIC) in crystalline quartz was studied by using 5-μsec pulses of electrons with an energy of 13 MeV. The variation with time of the RIC was found to depend on the direction of the applied electric field with respect to the c axis of the crystal, but not appreciably on the direction of the incident electron beam. Detailed dependence of the pulsed RIC on the angle θ between the applied electric field and the c axis was measured also for θ from 0 to 90° at intervals of 15°, and the variation with time of the RIC was found to be large for $\theta < 60°$ and very small for $\theta \geq 60°$. The dependence on θ was confirmed by measuring the average RIC with a picoammeter. (auth)

45553 ANNEALING OF ELECTRON-IRRADIATED n-TYPE SILICON: ILLUMINATION AND FLUENCE DEPENDENCE. Kimerling, L. C.; Carnes, C. P. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Appl. Phys.; 42: No. 9, 3548-52(Aug 1971).

The effects of strong illumination and radiation fluence on the annealing behavior of the E center in electron-irradiated phosphorus-doped float-zoned silicon were studied by Hall-effect measurement. Illumination of the sample during anneal increased the rate of recovery significantly. Increasing the radiation fluence and, hence, the level of the induced-carrier compensation, also increased the rate of anneal. These results were found to be consistent with a previously proposed model in which the charge state of the defect was found to be a major determinant of the activation energy of recovery. (auth)

45554 ION-IMPLANTED PHOSPHORUS IN SILICON: PROFILES USING C–V ANALYSIS. Moline, R. A. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys.; 42: No. 9, 3553-8 (Aug 1971).

Depth distributions are presented for 200-, 300-, and 600-keV phosphorus ions either channeled along the ⟨111⟩ axis or implanted away from any major axis or plane in silicon. The profiles were obtained using the differential capacitance technique, and the technique is discussed along with a description of an automatic data-acquisition system which allows precise C–V data to be accumulated. The "random"-direction implant profiles exhibit a definite exponential tail on the deep side of the implant. The characteristics of this tail appear to be material dependent but independent of the implantation energy. Thus, the tail probably results from an anomalous diffusion mechanism. The observed projected range for the random implants is 1.1 μm/MeV, with a range straggle nearly equal to that predicted by the range theory of Lindhard, Scharff, and Schiott (LSS). The channeled profiles exhibit a near flat characteristic to a depth of 2.2 $\mu m/(MeV)^{\frac{1}{2}}$. (auth)

45555 THERMALLY GENERATED ELECTRICAL CURRENTS IN γ-IRRADIATED LUCITE. Murphy, P. H.; Hoecker, F. E. (Univ. of Kansas, Lawrence). Radiat. Res.; 46: 1-15(Apr 1971).

Thin disks of commercial polymethylmethacrylate (Lucite), after having been exposed to γ rays, exhibit electrical currents, in the absence of an externally applied electric field when the samples are heated under the proper conditions. The currents are generated only if (a) the sample is heated with the maintenance of a temperature difference between the electrodes or (b) it is heated without a net temperature difference between the electrodes and the γ irradiation was directional with a net component normal to the electrode surfaces and with relatively high-energy photons. For case (a), the direction of charge movement corresponds to positive charge displacement toward the colder electrode. For case (b), the direction of charge movement corresponds to positive charge displacement toward the exit side of the sample. (auth)

45556 RADIATION EFFECTS IN ELASTICALLY STRESSED LiF CRYSTALS. Politov, N. G.; Paperno, I. M.; Razmadze, A. K. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 270-2(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 328-30(Jan 1971).

The stress–strain diagrams were determined for LiF crystals after x irradiation (dose = 8×10^4 R) at room temperature or 77°K. Some of the samples were irradiated in a stressed state (100 g/mm^2), and the photoelastic method was used to determine the activation stress at which a crystal became optically active. Irradiation reduced the activation stress, accelerated the diffusion of point defects, increased the strength, but had little effect on the maximum elongation except at 77°K. The results suggest that fewer carriers are generated and plastic properties are improved at lower temperatures. The aggregation of point defects into clusters reduces the number of dislocation-pinning points. (D.L.C.)

45557 RADIATION DAMAGE IN DIELECTRIC–SEMICONDUCTOR STRUCTURES. Mordkovich, V. N.; Zhukova, G. A.; Temper, E. M. Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 8, 1358-9(Feb 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 8, 1583-5(Aug 1970).

Irradiation of Si/SiO_2 structures with protons or neutrons may produce a positive or a negative charge. The process is complex, involving the production of defects as well as electron–hole pairs. Irradiation with reactor neutrons and gamma rays showed that neutrons produced a negative charge at the interface and that this charge increased with gamma dose. (D.L.C.)

45558 TEMPERATURE DEPENDENCE OF THE RATE OF FALL OF THE ELECTRON DENSITY IN n-TYPE Ge AND n-TYPE Si DURING FAST-NEUTRON IRRADIATION. Starostin, K. L. Sov. Phys.-Semicond. (Engl. Transl.); 4: No. 9, 1569-70(Mar 1971).

Translated from Fiz. Tekh. Poluprov.; 4: No. 9, 1823-4(Sep 1970).

The relative contributions of single defects and disordered regions to the measured rates of electron removal $dn/d\varphi$ are calculated. At temperatures below 220°K, the contribution of single defects decreases strongly, leading to a drop in $dn/d\varphi$. Above 220°K, the rate of introduction of single defects remains practically constant in n-type Ge and decreases slowly in n-type Si. The $dn/d\varphi$ values at these temperatures can be explained by a reduction in the size of the disordered regions and, in the case of n-type Si, by a downward shift of the Fermi level. (D.L.C.)

45559 MECHANISM OF IMPACT LUMINESCENCE IN X-IRRADIATED KCl CRYSTALS. Ezhik, I. I. (Kharkov Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 11-16(1971). (In Russian).

A mechanism is presented for the conversion of mechanical shock impulses directly into light impulses in x-irradiated crystals of KCl. The intensity of the impact luminescence and light flashes was studied as a function of temperature in the range 80 to 390°K. The process of luminescence production is discussed in terms of F- and R-color centers and a zonal diagram which depicts various energy levels. (K.S.W.)

45560 CONDUCTIVITY VARIATIONS IN CaF_2 CRYSTALS AS A RESULT OF ELECTRON IRRADIATION. Zavadovskaya, E. K.; Fedorov, V. A.; Lisitsyn, V. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 128-30(1971). (In Russian).

An investigation was conducted on the influence of 1.2-MeV electron irradiation on the conductivity of CaF_2 crystals. The radiation exposure gave rise to an increase in conductivity in the low-temperature region (30 to 100°C), and a decrease in the high-temperature region (100 to 500°C). With an increase in the radiation dose to 10^{15} electrons/cm^2, the conductivity in the low-temperature region increased more than two orders of magnitude, and then gradually decreased upon further irradiation. In the high-temperature region, however, the conductivity remained unchanged even at doses of 4×10^{14} electrons/cm^2, but then with further dosage decreased. Optical absorption spectra of electron-irradiated CaF_2 crystals contained four bands with maxima at 225, 335, 400, and 580 nm. Gradual heating to 240°C caused the disappearance of these bands. (K.S.W.)

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45561 THERMOLUMINESCENCE OF CaF_2 CRYSTALS IRRADIATED BY PROTONS AND ELECTRONS. Zavadovskaya, E. K.; Lisitsyn, V. M.; Fedorov, V. A.; Baranov, A. I. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 135-6(1971). (In Russian).

An investigation was made of the thermoluminescence of "pure" CaF_2 crystals when subjected to 4.5-MeV proton and 1.2-MeV electron irradiation at temperatures not exceeding 30°C. Doses of 9.4×10^{14} electrons/cm^2 resulted in CaF_2 crystals which, upon gradual heating, furnished luminescent peaks at 60, 105, 135, 220, 252, and 320°C. A dose of about 10^{18} electrons/cm^2 gave rise to only three peaks. Proton dosages of 9.4×10^{13} and 1.35×10^{16} protons/cm^2 resulted in CaF_2 crystals with five and three peaks, respectively. In general, the intensity of the luminescent peaks and their position depended on the type and dosage of the ionizing radiation. At small dosages, intense luminescent peaks were observed in the temperature interval 50 to 180°C, and weak peaks from 200 to 340°C. With increased dosage, the low-temperature peaks frequently disappeared. (K.S.W.)

45562 ACTIVATION ENERGY DETERMINATION IN PROCESSES RELEASING STORED ENERGY DURING ANNEALING OF RADIATION DEFECTS IN NaCl AND KCl. Borisovskii, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 142-3(1971). (In Russian).

The activation energy of defect migration was determined in NaCl and KCl crystals during the release of stored energy in the combined isothermal and isochronous annealing of radiation defects. The irradiation with 4.5-MeV protons furnished the defects whose stored energy was in turn released at room temperature in a microcalorimeter. The value for the activation energy in NaCl found in this manner agreed well with that of cationic vacancies; KCl failed this test, possibly because of the large concentration of defects in its structure. (K.S.W.)

45563 ANOMALOUS PHOTOVOLTAIC EFFECT IN THIN LAYERS OF GERMANIUM AND THE EFFECT OF ELECTRON BOMBARDMENT. Arifov, U. A.; Abdullaev, N.; Ayukhanov, A. Kh. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 41-4(1970). (In Russian).

Methods of forming films of Ge are discussed, and their subsequent use in studying the effect of electron beams is described. Germanium was vaporized in a vacuum from beryllia or alumina crucibles onto glass or quartz supports. The dark resistance and the photovoltage generated at room temperature were measured. The effect of electron bombardment on the photoelectric properties of the films was studied for the range of electron energies from 50 to 3000 V. With increased exposure to the electron beam, the photoelectric voltage dropped sharply and practically disappeared when the electron energy was increased to about 2000 V. (K.S.W.)

45564 ANOMALOUS-X-RAY-TRANSMISSION INVESTIGATION OF NEUTRON-IRRADIATED COPPER: COMPARISON OF THEORY AND EXPERIMENT. Larson, B. C.; Young, F. W. Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 4: No. 6, 1709-13(15 Sep 1971).

Anomalous-x-ray-transmission measurements were made on nearly perfect copper crystals that had been irradiated with fast-neutron doses varying from 3.6 to 10.9×10^{18}/cm^2 (E > 0.6 MeV). The observed decrease in intensities for 111, 220, and 222 reflections with CuKα, MoKα, and AgKα x rays was expressed in terms of effective absorption coefficients. These absorption coefficients increased linearly with neutron dose; they were analyzed in terms of the theory of Dederichs, and it was found that these data are consistent with the presence of defect aggregates in the form of dislocation loops. It was also found that the theory can explain the wavelength and reflection dependence of the observed absorption coefficients for these neutron doses when the calculations are scaled to the measured data for the 111 reflections of MoKα and CuKα radiations. Therefore, these data provided a successful test of the functional dependence of the theory, independent of the defect concentration and size distribution. (auth)

45565 PHOTOLUMINESCENCE OF RADIATION DEFECTS IN CUBIC SiC: LOCALIZED MODES AND JAHN–TELLER EFFECT. Choyke, W. J.; Patrick, Lyle (Westinghouse Research Labs., Pittsburgh). Phys. Rev., B; 4: No. 6, 1843-7(15 Sep 1971).

Radiation defects were introduced into cubic SiC by 120-keV He-ion implantation, or by 1-MeV electron bombardment Some of the defects persist after a 1600°C anneal. A low-temperature luminescence spectrum of one of the persistent defects reveals strong vibronic coupling, with localized and resonant modes. The spectrum has an unusual temperature dependence, with two abrupt changes below 13°K. The changes are attributed to the Jahn–Teller effect, and the distortion is accounted for by coupling with the 66.5-MeV resonant mode. A possible model for the defect is the Watkins–Corbett impurity–vacancy model that was found to be appropriate for several persistent defects in Si. (auth)

45566 HELIUM-TEMPERATURE ANNEALING OF ELECTRON-IRRADIATED n-TYPE GERMANIUM. Hyatt, W. D.; Koehler, J. S. (Univ. of Illinois, Urbana). Phys. Rev., B; 4: No. 6, 1903-10(15 Sep 1971).

n-type germanium (4×10^{14} Sb/cm^3) has been irradiated with 1.1-MeV electrons at 5°K. The defects produced have been studied by measuring the voltage-dependent capacitance of a metal/germanium junction formed at the surface of a germanium sample. These measurements were made at 10°K and directly gave the charge density near the surface of the sample. The production and recovery of defects seen near the surface is the same as seen in bulk experiments. A 0.5-MeV electron beam was used to cause radiation annealing of the defects at 5°K. The fraction recovered during radiation annealing is directly proportional to $t^{-\frac{1}{2}}$. A model based on diffusion-limited-recovery theory is used to explain these results. This model is also used to discuss the results of previous experiments. The temperature dependence of the observed recovery at 5°K gave a defect migration energy of 0.0044 ± 0.008 eV. (auth)

45567 ELECTRON PARAMAGNETIC RESONANCE OF THE NEUTRAL (S = 1) ONE-VACANCY-OXYGEN CENTER IN IRRADIATED SILICON. Brower, K. L. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., B; 4: No. 6, 1968-82(15 Sep 1971).

A new EPR spectrum, labeled Si–S1, was observed in electron- or neutron-irradiated, n- or p-type, crucible-grown silicon under illumination with approximately band-gap light. The Si–S1 spectrum consists primarily of a fine-structure spectrum and a ^{29}Si hyperfine spectrum. By incorporating ^{17}O atoms into vacuum-float-zone silicon by ion implantation, the Si–S1 ^{17}O hyperfine spectrum was also observed. An analysis of the coupling tensors in the spin Hamiltonian which characterize the fine structure and ^{29}Si hyperfine spectrum is presented and suggests that the Si–S1 center is the neutral charge state of the one-vacancy–oxygen center in an excited spin-triplet state. This model for the Si–S1 center is in agreement with stress measurements, which are also presented. These measurements indicate that the time–temperature dependence in the reorientation of the Si–S1 center is the same as that of the neutral one-vacancy–oxygen center as monitored by the Si–B1 spectrum. (auth)

45568 INFLUENCE OF COLOUR CENTERS ON DISLOCATION ETCHING IN NEUTRON-IRRADIATED BaF_2. Patel, A. R.; Singh, R. P. (Sardar Patel Univ., Vallabh Vidyanagar, India). pp 432-41 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218–(Vol.2).

Results of investigations of radioinduced defects in BaF_2 are reported. It was found that neutron irradiation induces defects in the crystals, however, these defects do not alter the positions of the as-grown defects. It was also found that a part of the radioinduced defects is likely to be color centers. (J.R.D.)

45569 EFFECTS PRODUCED BY ION BOMBARDMENT AND IMPLANTATION INTO THIN FILMS AND SURFACES. Collins, L. E.; O'Connell, P. A.; Perkins, J. G.; Pontet, F. R.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods; 92: No. 4, 455-9 (1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Some effects produced by ion bombardment and implantation into thin films and surfaces are reviewed. The increase in adhesion to the substrate caused by ion bombardment and the effect of surface implantation on the nucleation and growth of thin films formed by vapor deposition and electroless plating are discussed. The electrical properties of resistive oxide and cermet films produced by ion implantation are also reported. (auth)

45570 DEFECT INTRODUCTION RATES AND DEFECT IDENTIFICATION STUDIES IN LOW-ENERGY ELECTRON IRRADIATED SILICON. Hemment, P. L. F. (Univ. of Surrey, Guildford, Eng.); Stevens, P. R. C. Nucl. Instrum. Methods; 92: No. 4, 471-6(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The free carrier removal rate (CRR) and temperature dependence of the carrier concentration as determined from resistivity and Hall-effect measurements are used to determine defect introduction rates (DIR), produced in thin (10 to 40 μm) n-type silicon specimens irradiated with monoenergetic electrons (200 to 400 keV), at ≈80 K and ≈245 K. Carrier trapping levels are identified at $E_c - 0.13$ eV, $E_c - 0.18$ eV, and a deeper level, assumed to be

the E-center, at $E_c - 0.4$ eV. Displacement models and calculation, which suggest values of the threshold energy for atomic displacement ranging from 6 eV to 22 eV in the elemental semiconductors, are briefly discussed. (auth)

45571 HEAVY ION-INDUCED CHARACTERISTIC X-RAYS AS A TOOL IN SOLID STATE PHYSICS. Cairns, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 92: No. 4, 507-10(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Characteristic x-ray generation by accelerated heavy ions offers some distinct advantages over conventional electron bombardment methods. For example, "clean" x rays, free from background radiation, are generated; this allows the use of nondispersive x-ray counting procedures. In addition, the ability of heavy ions to generate x rays can be coupled with their property of channeling through a crystalline lattice, this coupling thus yielding a probe for locating the atomic positions of impurity elements in a crystalline matrix. More recent studies demonstrated that characteristic x rays of a particular element can be generated selectively in the presence of other elements by bombardment with an appropriate beam of heavy ions. Since the resultant x rays arise from near the surface of the target, there emerges a technique for elucidating, with high sensitivity, the concentration profile of an ion-implanted element. Finally, it should be noted that the x rays involved in this work are normally in the soft-to-ultrasoft energy range, i.e. ranging from ≈2 keV to ≈200 eV. A few recent developments in the design of gas-flow proportional counters for the detection of these low-energy x rays are therefore presented. (auth)

45572 ANALYSIS OF ELECTRICAL MEASUREMENTS OF ION-IMPLANTED LAYERS IN SEMICONDUCTORS. Stevens, P. R. C.; Tinsley, A. W. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Phys., C (London); 4: No. 9, L150-3(28 Jun 1971).

In the analysis of electrical measurements on ion-implanted layers in semiconductors, it is important to take account of the possibility of incomplete donor or acceptor ionization, and the fact that the material is likely to degenerate. Methods for computing these effects and the effect of mobility variation with depth are presented. (auth) (UK)

45573 THERMOLUMINESCENCE AND COLOUR CENTRES IN LiF CRYSTALS IRRADIATED AT ROOM TEMPERATURE. Nakajima, T. (National Inst. of Radiological Sciences, Chiba, Japan). J. Phys., C (London); 4: No. 9, 1060-8(28 Jun 1971).

Thermal bleaching of colour centres in irradiated LiF crystals at room temperature was studied under the same thermal conditions as for the measurement of thermoluminescence. When the irradiated crystals were annealed and rapidly cooled, the energy of formation of the trapping centres of carriers, which contributed to thermoluminescence, was estimated to be 0.13 eV. (auth) (UK)

45574 STUDY OF THE KINETICS OF THE ANNEALING PROCESS OF ADSORPTION AND PARAMAGNETIC CENTERS GENERATED BY IRRADIATION ON THE SURFACE OF γ-Al_2O_3 BY THE MONTE CARLO METHOD. Golubev, V. B.; Kolbanovskii, Yu. A.; Lebedev, S. N.; Masterova, M. N.; Polak, L. S. (Inst. of Petrochemical Synthesis, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 391-3(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 439-42(Sep-Oct 1970).

It is shown that the minimum energy depth of such centers in the forbidden band does not exceed 4 kT. The experimental kinetic curves agree well with the theoretical, obtained on the assumption of an exponential distribution of traps with respect to energy depth. (auth)

45575 ANNEAL BEHAVIOR OF ALUMINUM-IMPLANTED GERMANIUM. Itoh, Tadatsugu; Ohdomari, Iwao (Waseda Univ., Tokyo). Jap. J. Appl. Phys.; 10: No. 8, 1002-6(Aug 1971).

p-Type single-crystal germanium was implanted with 1.5×10^{15} aluminum ions/cm^2 at room temperature at 10 keV. Carrier distributions were determined by means of anodic stripping of thin layers combined with Hall-effect and sheet-resistivity measurements. Anneal behavior of crystalline states was investigated by observation of implanted surfaces using the reflection electron-diffraction technique after successive stripping of surface layers. It was found that some of the incident ions penetrate to about 1400 Å during room-temperature implantation, beyond the range predicted by LSS theory. The minority carriers of deeply penetrated aluminum occupy the substitutional sites and become acceptors, while the majority carriers remain electrically inactive. The lattice reordering takes place at 300 to 400°C but does not remarkably contribute to the increase in carrier concentration. Carrier concentrations increase remarkably after anneals at 500 to 600°C by the transition of aluminum atoms to the substitutional sites from the as-implanted inactive sites. Radiation-enhanced diffusion of aluminum as observed in silicon is not observed in germanium. (auth)

45576 DIFFUSION OF DEFECTS IN LOW TEMPERATURE ION IMPLANTED GaAs. Gamo, Kenji; Aoki, Kazunori; Masuda, Hohzoh; Namba, Susumu (Osaka Univ.). Jap. J. Appl. Phys.; 10: No. 8, 1118-19(Aug 1971).

The 80°K photoluminescence was measured in Te-doped n-type GaAs after 50-keV Cd ion implantations at 80, 200, and 300°K. The photoluminescence decreases strongly with dose for the 300°K implantation, while that for 80 and 200°K decreases very slowly, indicating that diffusion of the defects into the bulk occurs at 300°K. The photoluminescence is recovered slowly with increasing annealing temperature for the 80°K implantation. (D.L.C.)

45577 COERCIVE FIELDS OF ROCHELLE SALT HEAVILY IRRADIATED WITH γ RAYS. Abe, Ryuji; Mizuno, Osamu (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 10: No. 8, 1122 (Aug 1971).

Rochelle salt crystals were irradiated in-pile above the upper Curie point. For short irradiations (dose = 10^3 to 10^4 R), the effect is similar to that of x rays, in which the coercive force continues to increase for a month after irradiation. For long irradiations (dose > 10^5 R), the coercive force, while much higher than in unirradiated crystals, does not increase with time. The force has a maximum at ~1°C, and the upper and lower Curie points are shifted so as to narrow the ferroelectric region. The results in the heavy-dose region may be explained by assuming that domain wall motion is prevented by radicals formed in the irradiation. (D.L.C.)

Physical Properties

Refer also to abstracts 44501, 45048, 45054, 45066, 45069, and 45117.

45578 LATTICE REFRIGERATION BELOW 10^{-3} °K. Kos, J. F. (Univ. of Saskatchewan, Regina). Can. J. Phys.; 49: No. 12, 1687-90(15 Jun 1971).

A method is proposed whereby the lattice of some piezoelectric materials may be cooled below 10^{-3}°K, and possibly as low as 3×10^{-6}°K. (auth) (Canada)

45579 EVALUATION OF CRYSTALLINITY AND SURFACE AREA MEASUREMENTS OF PLUTONIUM DIOXIDE SAMPLES. Dias, R. M. A.; Chackraburitty, D. M. (Bhabha Atomic Research Centre, Trombay, India). J. Appl. Crystallogr.; 4: 74-5 (1971).

Plutonium dioxide samples, prepared from plutonium oxalate, plutonium nitrate, and plutonium sulfate, were heated at temperatures from 500 to 900°C, under standard conditions, and were examined by x-ray diffraction in silica capillaries of similar diameter at room temperature. The breadth of the diffraction lines was measured by a microdensitometer. Various parameters like crystallite size, shape of the crystallites, and surface area per unit mass were deduced. The crystallites were found to grow in size as the oxides were heated to progressively higher temperatures, and the surface area per unit mass decreased with the increase in size of the crystallites. The surface area values were higher for oxides prepared by the decomposition of oxalates than for those prepared from nitrate or sulfate. (auth)

45580 AN INITIAL COMPARISON OF THE ELASTIC PROPERTIES OF Dy AND Tb–50 PERCENT Ho. Jordan, R. G. (Univ. of Birmingham, Eng.). Solid State Commun.; 9: No. 12, 857-9 (15 Jun 1971).

The temperature variation of the c-axis lattice parameter of Tb–50% Ho is compared to that of Dy. The results confirm the similarity of the elastic properties suggested by previous magnetic measurements. (auth) (UK)

45581 MAGNETIC STRUCTURE OF HEXAGONAL $ErAl_3$. Bargouth, M. O.; Will, G. (Univ., Bonn.). Phys. Lett.; 36A: No. 1, 50-1(2 Aug 1971).

Hexagonal $ErAl_3$ was studied by neutron diffraction and the magnetic structure was determined. $ErAl_3$ orders antiferromagnetically with the moments directed along the c-axis. The observed magnetic moment is 6.15 μ_B at 2.15°K. (auth)

45582 LOW-TEMPERATURE SPECIFIC HEAT OF $ErAl_2$. Machado da Silva, J. M. (Clarendon Lab., Oxford). Phys. Lett.; 36A: No. 1, 75-6(2 Aug 1971).

The specific heat measurements on $ErAl_2$ show that the Er^{3+} ion is in a fully magnetized state and the high linear term in the

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specific heat below 1°K, $\gamma = 41.1 \pm 0.2$ mJ/(mole K^2), may be due to a magnon–electron contribution. (auth)

45583 LITHIUM DRIFTABILITY OF GERMANIUM GROWN FROM QUARTZ OR GRAPHITE CRUCIBLES. Fox, R. J.; Westbrook, R. D. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 94: No. 3, 561-4(1971).

Lithium-drift mobility and oxygen concentration were measured in pulled germanium crystals grown in a vacuum or hydrogen atmosphere using quartz or graphite crucibles. The highest values of mobility and lowest values of oxygen content were measured for crystals grown in vacuum from melts contained in graphite. The lowest mobilities and the highest oxygen levels occurred in crystals grown in hydrogen from melts contained in quartz. The effects were reversible. Driftable germanium was made to drift more slowly by regrowth in hydrogen and quartz; that material, in turn, was made to drift rapidly by regrowth in vacuum and graphite and, to a lesser extent, by regrowth in hydrogen and graphite or vacuum and quartz. Oxygen levels, determined by lithium precipitation, were consistent with mobility variations. (auth)

45584 PARAMAGNETIC RESONANCE AND LOCAL DEFORMATION IN COMPLEXES OF THE TYPE UF_6M. Rigny, P.; Dianoux, J.; Plurien, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Phys. Chem. Solids; 32: No. 6, 1175-80(Jun 1971). (In French).

In the complexes of formula UF_6M, with M = Na, Li, Cs, NO, the unpaired 5f electron is surrounded by an octahedron of fluorine atoms. Paramagnetic resonance studies show that the UF_6^- ions are slightly axially distorted. A calculation is presented, where crystal-field theory is used to calculate the strength of the distortion from the experimental g factors. The wave functions of a 5f electron in a cubic environment, quantized along a 111 axis of the octahedron are first determined. The validity of the results can be checked with UF_6Cs on which accurate crystallographic studies were made; values of the angles of distortion are proposed for the other complexes studied, for which paramagnetic resonance studies are much more sensitive than radiocrystallography. (auth) (UK)

45585 MAGNETIC SUSCEPTIBILITY OF URANIUM CARBONITRIDE AND OXYCARBIDE. Ohmichi, Toshihiko; Saito, Tamotsu (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 6, 314-18(Jun 1971).

The magnetic susceptibility of solid solutions of U(C, N) (up to 50 mol % UN) and U(C, O) (up to 25 mol % UO) was studied in the temperature range of 77 to 300°K. These solid solutions all exhibit paramagnetism. With U(C, N), the susceptibility rises with increasing content. With U(C, O), the susceptibility scarcely changes up to approximately 5 mol % UO, beyond which point it increases with oxygen content. The temperature dependence of the susceptibility, though very weak, increases with oxygen content. The density-of-state curve is considered on the assumption that the variation of susceptibility with composition is due to Pauli paramagnetism, and the magnetic behavior of U(C, N) and U(C, O) is explained by considering the shift of the Fermi level with progressive substitution of carbon by nitrogen or oxygen. (auth)

45586 MAGNETIC PROPERTIES OF UP–USe AND UAs–US SOLID SOLUTIONS. Trzebiatowski, W.; Palewski, T. (Inst. for Low Temperatures and Structure Research, Wroclaw. Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 2, 83-9(1971).

UP–USe and UAs–US solid solutions contain one antiferro- and one ferromagnetic component. The transitions from the antiferro- to the ferromagnetic state were investigated and T_N, T_C, θ, and μ_{ef} vs composition were determined. The results are discussed in terms of the super exchange via conduction electrons, and the change in electron concentration could result in changes in the magnetic-ordering type. (auth)

45587 CRYSTAL FIELD INTERPRETATION OF THE MAGNETIC PROPERTIES OF SOME URANIUM COMPOUNDS OF $AuCu_3$-TYPE STRUCTURE. Mulak, J.; Misiuk, A. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 3, 207-13(1971).

Based on the point-charge model, the crystal-field Hamiltonian of uranium in the compounds UX_3 with cubic $AuCu_3$-type structure was determined. Assuming localized $5f^2$ electrons of U, the splitting diagrams of the term $^3H_4$ for both negative and positive X were given. The analysis of temperature dependence of magnetic susceptibilities of UGe_3, and UPb_3 indicates that the negative formal charge should be assigned to the X atoms. Depending on the ratio of potential terms of the fourth and sixth orders, the nonmagnetic doublet Γ_3 or triplet Γ_5 can be ground state of the U^{4+} ion. The temperature-independent paramagnetism of USi_3 can be explained assuming both positive (Γ_1 as the ground level) and negative (Γ_3 as the ground level) formal charges of X. (auth)

45588 INFRARED SPECTRA OF CRYSTALS OF URANYL CHLORIDES IN POLARIZED LIGHT. Komyak, A. I.; Posledovich, M. R. Zh. Prikl. Spektrosk.; 12: 712-16(Apr 1970). (In Russian).

The spectra of $Rb_2UO_2Cl_4 \cdot 2H_2O$ and $Cs_2UO_2Cl_4$ were obtained with orientations of the electric vector of the infrared radiation parallel to the main crystallo-optical directions. Assignments in the spectrum of frequencies and established orientation of dipole moments are given. Considerations concerning the structure of the complex $Rb_2UO_2Cl_4 \cdot 2H_2O$ and its orientations in crystalline lattice are expressed. (tr-auth)

45589 DISLOCATION MODEL FOR TWO-LEVEL ELECTRON-HOPPING CONDUCTIVITY IN V_2O_5: IMPLICATIONS FOR CATALYSIS. Perlstein, Jerome H. (Johns Hopkins Univ., Baltimore). J. Solid State Chem.; 3: No. 2, 217-26(May 1971).

The electrical conductivity of single-crystal V_2O_5 and V_2O_5 doped with copper (α phase) was measured along the c axis from 77°K to 298°K. Ln σ vs $1/T$ can be approximated by two straight lines with an average activation energy above 170°K of 0.20 eV and below 170°K of 0.077 eV. Comparison with EPR data and with the V_2O_5 β phase leads to an interpretation for the high-temperature conductivity as arising from thermal excitation of electrons from vanadium-pair traps with an activation energy of 0.15 eV and electron hopping from one vanadium site to another with an activation energy of 0.05 eV. Together with the Seebeck coefficient, the low-temperature data also require direct electron hopping between traps with an activation energy of 0.077 eV. A dislocation model is presented to account for the vanadium pair traps, the electrical conductivity, and EPR data. The model requires the formation of interstitial oxygen which may be involved in the catalytic properties of V_2O_5. (auth)

45590 REVERSAL OF COUPLING IN INTERMETALLIC COMPOUNDS CONTAINING TWO RARE EARTH ELEMENTS. Swift, W. M.; Wallace, W. E. (Univ. of Pittsburgh). J. Solid State Chem.; 3: No. 2, 180-3(May 1971).

The reversal in coupling (from antiferromagnetic to ferromagnetic order with increasing x) in $Eu_xLa_{1-x}Al_2$ ternaries is successfully analyzed in terms of the RKKY formalism. The Fermi wave vector k required to account for the behavior of these ternaries is $k = 0.94\ k_0$, which is in close agreement with the k-value previously obtained for $GdAl_2$ and $GdAl_2$-based ternaries from NMR work. The similarity of behavior of $Gd_{0.1}La_{0.9}Al_2$ and $Eu_{0.1}La_{0.9}Al_2$ and their observed Curie temperatures can also be understood using the same theoretical framework and approximately the same k-values. (auth)

45591 STRUCTURAL AND MAGNETIC CHARACTERISTICS OF Th–Co AND Th–Fe COMPOUNDS. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys.; 42: No. 9, 3433-7(Aug 1971).

The Th–Co and Th–Fe systems were studied by x-ray diffraction methods. Five intermetallic compounds were observed in each system. For each of these compounds the lattice parameters were determined. The magnetic properties of the various compounds were investigated at temperatures between 4.2 and 1200°K with magnetic field strengths up to 30 kOe. In the Th–Co system, the compounds Th_2Co_{17} and $ThCo_5$ are ferromagnetic; the Curie temperature and the cobalt moment decrease rapidly with Th-content. The compounds Th_2Co_7, ThCo, and Th_7Co_3 are paramagnetic. In the Th–Fe system the compounds Th_2Fe_{17}, $ThFe_5$, Th_2Fe_7, and $ThFe_3$ are ferromagnetic; with increasing Th content the Curie temperatures and iron moments first rise, then decrease. The compound Th_7Fe_3 is paramagnetic. A comparison is made with the magnetic properties of rare-earth–iron and –cobalt compounds. Magnetic data are reported for La_3Co, Y_3Co, and YCo_2 which are paramagnetic. Curie temperatures are also given for YCo_3 and YCo_5. (auth)

45592 INITIAL SUSCEPTIBILITY STUDY OF THERMAL HYSTERESIS IN Gd IN THE NEIGHBORHOOD OF THE CURIE REGION; FREQUENCY DEPENDENCE OF THE MAGNETIZATION. Gerstein, B. C.; Olander, F. (Iowa State Univ., Ames). J. Appl. Phys.; 42: No. 9, 3438-45(Aug 1971).

Initial susceptibility measurements as a function of frequency and field were made on two samples of polycrystalline gadolinium in the range 200 to 296°K at frequencies of 20 to 200 Hz and fields of 2 to 25 Oe. Both samples exhibited thermal hysteresis in both real and imaginary susceptibilities between 260 and 290°K. The absorption was more sensitive to the hysteresis than was the dispersion by a factor of 5. The nature of the susceptibility–temperature–frequency surface was delineated for both the real and imaginary components. A driven oscillator model failed to account for the frequency dependence of the susceptibility, the failure in the model being qualitatively similar to that observed in similar results obtained for holmium. (auth)

45593 NEUTRON COUNTER OF HOT AND COHERENT PHONONS. Mitin, A. V.; Khabibullin, B. M. (Physical-Tech-

nical Inst., Kazan). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 215-16(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 274-5(Jan 1971).

A method using inelastic coherent scattering of slow neutrons to study "hot" phonons (impurity spin system) in a lattice is suggested, which can be employed in the vibration frequency range 10^{10} Hz to the Debye frequency. Under steady-state saturation conditions, an experimental study of "hot" phonons can be carried out most conveniently in MgO crystals with Ni^{2+} or Fe^{2+} impurities. The ratio of the cross sections for inelastic scattering before and after saturation is ~30. The use of this method to study the "hot"-phonon frequency distribution, phonon avalanches, and high-frequency acoustic vibrations is suggested. (D.L.C.)

45594 NEUTRON-DIFFRACTION STUDY OF HEMATITE IN MAGNETIC FIELDS UP TO 120 kOe IN A FAST PULSED REACTOR. Antsupov, P. S.; Voskanyan, R. A.; Levitin, R. Z.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR, Scientific-Research Physicochemical Inst., Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 44-9(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 56-62(Jan 1971).

A neutron-diffraction method was developed for studying the magnetic structure of magnetic materials in high quasi-steady-state magnetic fields. The method was applied to the hematite crystal at liquid-nitrogen temperature in fields up to 120 kOe. The magnetization mechanism proposed earlier is confirmed (the field is parallel to the two-fold axis); this mechanism involves a rotation of spins from the three-fold axis in the basis plane. The direction of the rotation is determined. An anomaly in the neutron scattering is found at a field of about 50 kOe. (auth)

45595 METAMAGNETISM IN Mn_3B_4. Timoshchuk, V. I.; Fakidov, I. G. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 85-7(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 107-10(Jan 1971).

Results are given of measurements of the magnetization σ of the compound Mn_3B_4 in pulsed fields up to 450 kOe. This compound may exist in two magnetic states, AF_I and AF_{II}, which differ in magnetic structure. The $\sigma(H)$ curve of the compound in the low-temperature state (AF_I) displayed an abrupt rise in σ, apparently associated with the breaking up of a spiral magnetic structure. This experimental fact, as well as the previously observed positive sign of the asymptotic Curie point θ, allowed the conclusion that the compound may be metamagnetic in the AF_I state. The experimental saturation magnetization exceeds by ~1.5 times that calculated from the Curie–Weiss constant. A possible mechanism for this phenomenon is discussed. (auth)

45596 DEBYE–WALLER FACTOR AND LATTICE PARAMETER OF SMALL METAL PARTICLES. Petrov, Yu. I.; Kotel'nikov, V. A. (Inst. of Chemical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 255-7(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 313-15(Jan 1971).

An x-ray-diffraction investigation was carried out on Au and Cu particles, and the changes in the characteristic temperature θ were determined by measuring the lattice parameter. The temperature dependences of the integrated intensities and θ showed θ to be 150 and 276°K for small Au and Cu particles, and 171 and 307°K for large Au and Cu particles, respectively. This 10 to 12% reduction leads to the prediction of a lattice parameter increase, which was not observed experimentally. Thus, the weakening of the intensity is mainly due to other causes than the change in the Debye–Waller factor. An explanation is offered for the small increase in the lattice parameter. (D.L.C.)

45597 COHERENT EXCITATION OF SPIN WAVES AND DOPPLER EFFECT EXPERIENCED BY POLARIZED NEUTRONS. Drabkin, G. M.; Marchik, I. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 258-9(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 316-17(Jan 1971).

Free oscillations of the magnetization can be excited in a single crystal of ferrite in a microwave magnetic field. Spin waves excited in this way should have a definite phase relationship (coherence and monochromaticity) with the exciting field; thus, a standing magnetization wave should be established, and neutrons traveling across the ferrite should experience a Doppler effect. Equations are derived for the probability of neutron-spin flip at the resonance point, and the feasibility of studying yttrium garnet is considered. (D.L.C.)

45598 REFLECTIVITY OF THE METALLIC PHASE OF V_2O_3. Zhuze, V. P.; Lukirskii, D. P.; Startsev, G. P. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 1, 260-1(Jul 1971).

Translated from Fiz. Tverd. Tela; 13: No. 1, 317-19(Jan 1971).

The reflection coefficient of unpolarized light on a V_2O_3 single crystal at room temperature was measured in the 0.11- to 25-μ range. The optical constants (refractive index and extinction coefficient) were calculated using Kramers–Kroenig and Beattie methods. The effective mass of the carriers (holes) was determined to be $m^* = 11\ m_0$, and the relaxation time τ is 2.4×10^{-15} sec. Good agreement of the experimental reflection data with the theoretical dependence $R(\lambda)$ was found. (D.L.C.)

45599 NEW ASPECTS OF CYCLOTRON RESONANCE IN CADMIUM. Ch'en, Daniel Ray. Berkeley, Calif.; Univ. of California (1970). 63p. University Microfilms Order No. 71-15,742.

Thesis.

Azbel'–Kaner cyclotron resonance measurements at 32 GHz and at temperatures between 1.5 and 7°K are reported for the $(11\bar{2}0)$ and (0001) crystal planes of cadmium. A new technique was developed to produce very pure cadmium crystals with optically flat surfaces and a value of $\omega_H\tau$ as high as 50 at 4.2°K. These flat surfaces allowed, for the first time, the elimination of tip effects, thus making possible very accurate cyclotron mass measurements. Twelve distinct mass series were observed, and measurements of their mass values were made as a function of the orientation of the dc magnetic field. Eight of these mass series showed general agreement with the previously reported results of Shaw, Eck, and Zych, and Galt, Merritt, and Klander. The angular ranges of observation were extended for four of these resonances. In addition, four mass series not previously reported by these investigators were observed and their orbits identified on the Fermi surface. Several mass series arising from the extended zone orbits were shown to be in general agreement with the results reported by Naberezhnykh, Mai'Yakhin, and Mel'Nik. The discrepancies of previously reported mass values as well as several unidentified mass series were shown to be due to tip effects. The effective mass anisotropy measured by this experiment is in agreement with the current model of the Fermi surface of cadmium. The temperature dependence of the cyclotron effective mass of two orbits on the third-zone lens surface was investigated for the first time. A mass increase of more than 5% was observed over a temperature range of 1.5 to 6.5°K. The mass enhancement was found to be proportional to T^2 in agreement with the theoretical calculations of Allen and Cohen. (Diss. Abstr. Int., B)

45600 MAGNETIC EXCITON DISPERSION IN PRASEODYMIUM. Rainford, B. D.; Houmann, J. Gylden (Danish Atomic Energy Commission Research Establishment, Roskilde, Denmark). Phys. Rev. Lett.; 26: No. 20, 1254-6(17 May 1971).

Measurements of the dispersion of magnetic excitons were made in a single crystal of praseodymium metal using inelastic neutron scattering. A preliminary analysis of the data yields the first detailed information about the exchange interactions and the crystal-field splittings in the light rare-earth metals. (auth)

45601 INFRARED AND RAMAN SPECTRA OF SOLID BERYLLIUM BOROHYDRIDE, BeB_2H_8. Nibler, Joseph W. (Oregon State Univ., Corvallis); Shriver, Duward F.; Cook, Thomas H. J. Chem. Phys.; 54: No. 12, 5257-66(15 Jun 1971).

Infrared and Raman spectra of solid BeB_2H_8, BeB_2D_8, $Be^{10}B_2D_8$, and BeB_2D_7H were obtained at 20 and 180°K. These data indicate that a structural change occurs in going from the vapor to the solid and suggest the presence of the borohydride anion, BH_4^-, paired with an unusual hydrogen bridged cation, $^+BeBH_4$. A detailed examination of the isotopic frequency shifts supports this view and an excellent fit of the BH_4^- frequencies is obtained from a normal coordinate analysis. Reasonable assignments of the $^+BeBH_4$ fundamentals are given and the structure of the $^+BeBH_4$ ion is discussed. (auth)

45602 STUDY OF THE OPTICAL PROPERTIES OF THIN RARE-EARTH FILMS IN STATIC ULTRAHIGH VACUUM. Petrakian, J. P. (Univ., Marseille). pp 589-94 of Congres International Sur Les Couches Minces. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1970). (In French).

From Conference on thin films; Cannes, France (5 Oct 1970). See CONF-701032.

It is shown that yttrium and five other heavy rare-earth metals (Gd, Tb, Dy, Ho, and Er) have the same optical behavior. The optical absorption spectra of these metals present two peaks. The maximum near 2.5 eV in the visible energy range is probably due to a vertical interband transition, although some of its characteristics are those of plasma oscillations. At 5.5 eV, the observed peak characterizes the bulk metal and is due to an interband transition. (auth) (France)

45603 LOCALIZED VERSUS COLLECTIVE ELECTRON BEHAVIORS IN OXIDE MATERIALS. Rao, C. N. R.; Subba Rao, G. V. (Indian Inst. of Tech., Kanpur). pp 325-35 of Symposium on Materials Science Research, National Aeronautical Laboratory, Bangalore, February 24–27, 1970. Bombay; Dept. of Atomic Energy (1970).

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From Symposium on materials science research; Bangalore, India (24 Feb 1970). See CONF-700218-(Vol.1).

Information is reported very briefly on the following: electric transport properties of various rare earth oxides; optical and electric properties of rare earth perovskites; electric conductivity of Bi_2O_3; and semiconductor–metal transitions in VO_2, NbO_2, $V_{1-x}Ti_xO_2$ ($0.0 \leq \times \leq 0.4$), and $V_{1-x}Nb_xO_2$ ($0.1 \geq \times \geq 1.0$) from electric conductivity studies. (L.M.T.)

45604 USE OF THERMIONIC EMISSION IN STUDYING POINT DEFECTS AT HIGH TEMPERATURES: CASE OF YTTRIUM OXIDE. Odier, Philippe; Anthony, Anne-Marie; Loup, Jean-Pierre (CNRS, Orleans-la-Source, France). Compt. Rend., Ser. B; 272: No. 22, 1263-6(2 Jun 1971). (In French).

Studies of thermionic emission from yttrium oxide, at high temperature and in equilibrium with an oxygen pressure, confirmed that the process is a method of studying point defects. (France)

45605 SECOND EUROPEAN CONFERENCE ON THERMOPHYSICAL PROPERTIES OF SOLIDS AT HIGH TEMPERATURES, SALFORD, ENGLAND, APRIL 7–10, 1970. Rev. Int. Hautes Temp. Refract.; 7: No. 4, 308-409(Oct-Dec 1970). (In French and English). (CONF-700431).

Eleven separate papers were abstracted on the measurement of thermal conductivity and thermal diffusivity (in insulators, Be, Hf, Nb, Zircaloy-2, W, ZrC, and NbC, cermets and carbons) and on the study of point defects in oxides and the measurement of the resistivity of Mo; one paper had already appeared in NSA (24: 46389) and is not included here. The remaining papers were not in scope for NSA. (France)

For abstracts of individual chapters see: 45066–45069, 45127, 45128, 45158, and 45606–45608.

45606 ELECTRIC CONDUCTIVITY OF REFRACTORY OXIDES AT HIGH TEMPERATURES. Anthony, A. M. (CNRS, Orleans-La-Source, France). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 365-77(Oct-Dec 1970). (In French).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

Refractory oxides are excellent insulators at room temperature, but they exhibit at high temperature electric conductivity of both the ionic and electronic type. The origin of the charge carriers is essentially due to the appearance of faults in the oxide lattice structure. The magnitude of the electric conductivity and of the transport number together with knowledge of the sign of the Seebeck effect gives valuable information about the conduction mechanism in the refractory oxides. Refractory oxides were used as heating elements for high-temperature furnaces ($T > 2000°K$) in oxidizing atmospheres. Oxides that were ionic conductors were studied for use in fuel cells and those that were electronic-conducting were tested as electrodes for the conversion of energy by the magnetohydrodynamic method. (France)

45607 STUDY OF ATOMIC POINT DEFECTS IN OXIDES BY MEANS OF THERMAL EMISSION OF ELECTRONS. Loup, J. P.; Odier, P. (CNRS, Orleans-la-Source, France). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 378-81(Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

The thermal emission of electrons from Rh, Y_2O_3, and ZrO_2 was studied at oxygen pressures from 10^{-6} to 10^{-11} atm. The emission from a metal is controlled by surface oxidation and the emission from an oxide at high temperature depends on the donors and acceptors present in the volume of the oxide; this is confirmed by measurements of conductivity. The study of electron emission is a technique which gives information on the nature of the atomic point defects in the oxides. In the case of zirconia, the point defects are the oxygen vacancies and the oxygen interstitials. (France)

45608 ELECTRICAL CONDUCTIVITY OF CERMETS. Ondracek, G.; Schulz, B. (Kernforschungszentrum, Karlsruhe, Ger.). Rev. Int. Hautes Temp. Refract.; 7: No. 4, 397-401 (Oct-Dec 1970).

From second European conference on thermophysical properties of solids at high temperatures; Salford, England (7 Apr 1970). See CONF-700431.

The problem discussed is the evaluation of the electric conductivity of a cermet as a function of the conductivity of the component phases, their concentration, and some stereometric factors. There exist about 40 equations in the literature that are useful for stable but not for unstable cermets; they can be classified in two groups: equations in which Ohm's law is used and equations in which the differential form of the field equations is used. The following parameters are considered: structure, distribution of the phases, and particle shape. Their effect on the conductivity is discussed on the basis of special criteria. Experimental values for the specific electrical resistance are compared with the theoretical values calculated using these equations. (France)

45609 IMAGES OF THORIUM ATOMS IN TRANSMISSION ELECTRON MICROSCOPY. Hashimoto, Hatsujiro (Kyoto Technical Univ.); Kumao, Akihiro; Hino, Kinnosuke; Yotsumoto, Haruo; Ono, Akinari. Jap. J. Appl. Phys.; 10: No. 8, 1115-16 (Aug 1971).

In order to make single Th atoms visible in a transmission electron microscope, 100-Å-thick graphite crystals were used as supporting films, and the images were taken with a JEM-100B electron microscope under dark field with the objective aperture at the axial position. The specimens observed were thorium nitrate reacted with benzeneteracarboxylic acid (BTCA) and small ThO_2 crystals. The dark field image of the Th-BTCA specimen showed many bright spots of ~3Å dia, with a spacing of 10Å. The ThO_2 image spots agree with the Th atoms in the $(10\bar{1})$ plane of thorium oxide cubic crystal. (D.L.C.)

45610 MAGNETIC STATES IN AMORPHOUS 41Pd–41Ni–18B ALLOYS CONTAINING CHROMIUM AND IRON. Liang, Victor K. C. Pasadena, Calif.; California Inst. of Tech. (1971). 166p. University Microfilms Order No. 71-17,381.

Thesis.

Amorphous alloys $Pd_{41}Ni_{41}B_{18}$ containing up to 4 at. % of Cr or Fe were obtained by rapid quenching from the liquid state. The electric resistivity of these alloys was measured as a function of concentration and temperature in order to gain some understanding of the effect of spin correlation on electronic conduction in amorphous solids. The resistivity vs temperature curve (ρ vs T) for the amorphous alloys containing Cr exhibit all the characteristics of a Kondo system. An excellent agreement is found between the present resistivity data and Hamann's theoretical prediction. It is shown that the resistivity of all the Cr alloys studied can be adequately represented by a universal function of reduced temperature (T/T_K) which is defined as the ratio of temperature to Kondo temperature. The experimental results are used to make a comparison between the Kondo theory and the Hamann theory. The latter is found to be superior to the former. It is also found that when the interaction between magnetic spins is no longer negligible, the experimental results show two important deviations from those obtained in dilute magnetic systems: (1) the unitarity limit ρ_0 does not scale with the concentration and (2) the Kondo temperature increases linearly with concentration. The electric resistivity of the basic alloy containing up to 4 at. % of Fe was also measured. The temperature dependence of the ρ vs T curves agrees very well with the theory of Turner and Long. It is also found that the alloys are ferromagnetic only above a certain critical Fe concentration. A simple physical model based on the interaction between the s-electron polarization spheres about the magnetic spins is proposed. This model successfully explains the observed deviations in the Cr alloys mentioned above. It also accounts for the existence of a critical concentration for ferromagnetism in the Fe alloys. Estimated values of the radii of the polarization spheres around the Cr and the Fe spins in the amorphous alloys and the corresponding exchange integrals are given. Based on this information it is concluded that the direct coupling between d spins is weaker in an amorphous alloy than in a corresponding crystalline alloy. Hence, amorphous alloys are ideally suited for studying the effects of s-electron correlations. (Diss. Abstr. Int., B)

Moessbauer Effects and NMR

45611 NUCLEAR MAGNETIC RESONANCE STUDY OF β-RHOMBOHEDRAL BORON AND BORON CARBIDE. Hynes, Thomas V.; Alexander, Michael N. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Chem. Phys.; 54: No. 12, 5296-5310(15 Jun 1971).

The ^{11}B nuclear magnetic resonance (NMR) in β-rhombohedral boron and in boron carbide was investigated at room temperature. Continuous wave (cw) measurements were performed at NMR frequencies 2 to 22 MHz, and pulse measurements at 29.5 MHz. Because of the crystal symmetry and the large number (105) of atoms per unit cell, the NMR in single-crystal β-rhombohedral boron is characterized by a very complex first-order quadrupole spectrum which is extremely sensitive to crystal orientation in the magnetic field. Measurements were made on powders to observe the orientation average of the spectrum, and first- and second-order quadrupole interactions were observed. The cw spectrum is a superposition of spectra corresponding to quadrupole coupling constants $\nu_{Q1} = 680 \pm 70$ kHz (this apparently being the central value for a distribution of electric field gradients whose spectra cannot be re-

solved) and ν_{Q2} in the range $90 \lesssim \nu_{Q2} \lesssim 170$ kHz. There may also be a few sites for which $\nu_{Q3} \cong 0$ ($\nu_Q = eqQ/2$). The intensities of the spectra corresponding to the various quadrupole couplings were measured by a cw technique, and also by a pulse technique which utilizes the fictitious spin-½ formalism. 80% ± 5% of ^{11}B nuclei in β-rhombohedral boron were found to experience the quadrupole ν_{Q1} = 680 kHz, corresponding to the fact that 80% of the atoms in the crystal are six-coordinated with icosahedral nearest-neighbor linkages. The spin–lattice relaxation mechanism in β-rhombohedral boron was found to be quadrupolar in nature. The spin–lattice recovery following a saturation pulse sequence can be fitted by the sum of two exponentials having time constants 5 and 52 msec (the central transition was observed). When the time constants are "normalized" so that only phonon contribution to the relaxation is considered, the strength of the spin–phonon interaction is found to be extremely large (more than an order of magnitude greater than in any alkali halides). The cw spectrum in a powder of boron carbide was found to be similar to that of β-rhombohedral boron in that it is characterized by quadrupole couplings $\nu_{Q_a} = 520 \pm 30$ and $\nu_{Q_b} < 30$ kHz. At higher NMR frequencies an additional powder pattern was observed which has divergences corresponding to $\nu_{Q_c} = 2.74 \pm 0.10$ MHz. Intensity measurements showed that 4 ± 2 times as many ^{11}B nuclei experience the coupling ν_{Q_a} as experience ν_{Q_b}; the powder pattern which has divergences corresponding to ν_{Q_c} arises from 17%–58% of all ^{11}B nuclei in the boron carbide crystal. These results lend support to a model of the boron carbide crystal which assigns a boron atom to the central position of the three-atom chain and a carbon atom to the icosahedron (which, in the usual simple models of boron carbide, is assumed to be occupied only by boron atoms). (auth)

45612 POLARIZED γ-RAY TRANSITION PROBABILITIES, IN THE CASE OF COUPLED ELECTRIC AND MAGNETIC HYPERFINE INTERACTION. Barb, D.; Constantinescu, S.; Tarina, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 3, 263-74(1971).

Formulas for direct calculation of the relative elliptically polarized γ-multipole mixture emission and absorption probabilities are given in the case of Moessbauer transitions between mixed wave functions for any spin values and parities of the corresponding states. The expression of the emission probability is applied in the case of the transition $3/2 \rightarrow 1/2$ for coupled electric and magnetic hyperfine interactions. (auth)

Theoretical Physics

Refer also to abstracts 45292 and 46025.

45613 (JINR-P2-5809) SYMMETRIZATION OF THE WAVE FUNCTIONS OF IDENTICAL PARTICLES AND THE PRINCIPLE OF THE QUANTUM-MECHANICAL AMPLITUDE INTERFERENCE. Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The wave functions of identical particles are interpreted more accurately. It is shown that the principle of the amplitude interference (which corresponds to indistinguishable ways) together with the normalization condition for the probabilities determine unambiguously the wave function structure for identical particles. The problem of possible monitoring of two particles with nonorthogonal inner states is discussed. (auth)

45614 FEW-BODY WATSON–FADDEEV EQUATIONS IN THE MANY-BODY PROBLEM. Rosenberg, Leonard (New York Univ., N. Y.). Phys. Rev., A; 4: No. 2, 734-8(Aug 1971).

Integral equations of the Watson–Faddeev type, developed in the context of few-body nonrelativistic scattering theory, are shown to play an important role in the structure analysis of many-body Green's functions and in variational techniques for the approximate determination of these Green's functions. Such equations sum up an infinite chain of few-body correlations. Those correlations which are not of this form, i.e., the intrinsic many-body correlations, are accounted for by the appearance of an effective (or "renormalized") interaction, as can be seen by direct transformation of the exact Martin–Schwinger equations for the Green's functions. For a given choice of effective interaction, the few-body correlation functions must be determined self-consistently. The Schwinger variational principle, originally developed for linear integral equations, is nevertheless the key element in a variational formulation of the nonlinear equations encountered here. For simplicity, attention is confined to equations that determine the two-body Green's function, although the entire procedure can be generalized to higher orders. (auth)

45615 MULTIPLE SCATTERING OF SLOW PARTICLES. Gott, Yu. V. Zh. Eksp. Teor. Fiz.; 60: No. 4, 1291-4(Apr 1971). (In Russian).

The angular distribution of particles traversing a layer of matter is calculated on the assumption that the potential for interaction between the particles and target atoms is of the form r^{-2}. It is shown that the theoretical angular distribution is close to the experimental distribution for protons with an energy of several keV. (auth)

45616 RELATIVISTIC MOTION OF A SINGLE PARTICLE UNDERGOING CYCLOTRON RESONANCE IN A MAGNETIC MIRROR TRAP. Faulconer, David White. Ithaca, N. Y.; Cornell Univ. (1971). 93p. University Microfilms Order No. 71-15,624.

Thesis.

The relativistic motion of a single particle undergoing cyclotron resonance in a magnetic mirror trap is studied. The Krylov–Bogolyubov method of averaging is employed to derive equations indicating an upper bound on particle energy. Smallness parameters necessary for the validity of these equations are made explicit. Limitation on particle energy absorption is found for a much broader class of particles than previously known. The relationship of this to experiment is discussed. (Diss. Abstr. Int., B)

45617 CHERENKOV RADIATION OF PARTICLES IN NONLINEAR ISOTROPIC MEDIA. Demchenko, V. V.; El-Siragy, N. M. (Atomic Energy Establishment, Cairo). Phys. Lett.; 36A: No. 1, 73-4(2 Aug 1971).

The "cubic" nonlinearity effect on the nature of Cherenkov radiation of particles is investigated. It is shown that, under certain conditions, nonlinearity of the medium initiates radiation not subjected to the radiation in linear approximation. (auth)

45618 CLASSICAL RELATIVE MOTION OF 2 PARTICLES. Banks, D.; Percival, I. C.; Wilson, J. McB. (Univ. of Stirling, Scotland). Comput. Phys. Commun.; 2: No. 2, 114-23(Feb-Mar 1971).

A flexible representation of the classical relative motion of two particles interacting through a general central force is presented. A general terminology of states and frames is introduced that allows changes from one state or frame to another to be defined. The frame changes are analytic. The state changes are made by solution of Newton's equations of motion using a fourth-order Runge–Kutta formula. The program requires 20,000 24-bit words of storage; it is written in FORTRAN for the ELLIOT 4130 computer. (R.W.R.)

45619 RADIATION FIELD OF A CHARGE MOVING ON A STRAIGHT LINE. Alevisos, J. O. (Varvakion Normal School, Athens). Amer. J. Phys.; 39: No. 9, 1052-5(Sep 1971).

A derivation of the radiation field of a charge accelerating on a straight line is presented that makes use of Gauss' law in a direct manner and does not make use of the concept of lines of force. (auth)

45620 MAXWELL EQUATIONS: NONRELATIVISTIC AND RELATIVISTIC DERIVATIONS FROM ELECTRON THEORY. de Groot, S. R. Studies in Statistical Mechanics. Volume IV. New York; American Elsevier Publishing Company, Inc. (1969). 179p. $8.95.

The historical development of the Maxwell equations is reviewed. Derivations are given for the atomic field equations and the macroscopic field equations using both non-relativistic and covariant theory. (M.O.W.)

45621 RELATIONSHIP BETWEEN NONLOCAL AND VELOCITY-DEPENDENT POTENTIALS. Kiang, D. (Dalhousie Univ., Nova Scotia, Can.). Amer. J. Phys.; 39: No. 9, 996-1002(Sep 1971).

The statement that a nonlocal potential is equivalent to a velocity-dependent potential is examined. Problems which arise from the expansion of a nonlocal potential into a finite power series in the momentum operator p are discussed. (auth)

45622 LOCAL OBSERVABLES IN QUANTUM THEORY. Hestenes, David; Gurtler, Richard (Arizona State Univ., Tempe). Amer. J. Phys.; 39: No. 9, 1028-38(Sep 1971).

The Pauli theory of electrons is formulated in the language of multivector calculus. The advantages of this approach are demonstrated in an analysis of local observables. Planck's constant is shown to enter the theory only through the magnitude of the spin. Further, it is shown that, when obtained as a limiting case of the Pauli theory, the Schroedinger theory describes a particle with constant local spin. An important consequence of this result is the realization that the usual interpretations of the Dirac and Schroedinger theories are mutually inconsistent in certain details. (auth)

XUM

45623 QUANTIZING ANGULAR MOMENTUM VIA THE SIMPLE HARMONIC OSCILLATOR. Friedman, Charles P.; Taylor, Edwin F. (Massachusetts Inst. of Tech, Cambridge). Amer. J. Phys.; 39: No. 9, 1073-8(Sep 1971).

The quantization of orbital angular momentum can be introduced simply through the model of the two- and three-dimensional simple harmonic oscillator. Most of the analysis is carried out in the familiar Cartesian coordinate system in which the simple harmonic oscillator Schroedinger equation is separable. Angular momentum eigenfunctions are constructed by superposition, and the resulting functions easily transformed into spherical coordinates. The angle-dependent parts of the solutions are the spherical harmonics, which are the orbital angular momentum eigenfunctions for all central potentials, including the Coulomb potential of the hydrogen atom. The method also introduces the separation-of-variables technique and provides practice in applying the concepts of completeness, orthogonality, superposition of states, and alternative representations. (auth)

45624 POSSIBILITY OF MEASURING SIMULTANEOUSLY THE COORDINATES AND THE MOMENTUM OF A PARTICLE FOR A PAST EVENT. Terletsky, Jacob; De Broglie, Louis (Institut de France, Paris). Compt. Rend., Ser. B; 272: No. 20, 1161-3(17 May 1971). (In French).

A method for measuring simultaneously the coordinate and the momentum of a particle with higher accuracy than with the Heisenberg uncertainty relations is presented. The results, however, cannot be more precise than those predicted in the framework of quantum mechanics but they confirm the conceptions of the double solution theory. (France)

45625 UNITARY EQUIVALENCE OF FOCK REPRESENTATIONS ON THE WEYL ALGEBRA. Van Daele, A.; Verbeure, A. (Univ., Louvain, Belgium). Commun. Math. Phys.; 20: No. 4, 268-78(1971).

A necessary and sufficient condition for unitary equivalence of pure quasi-free states over the Weyl algebra is proved. Some partial results on states over the Weyl algebra are formulated.(auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 45843.

45626 (ORO-3065-21) PROGRESS REPORT [ON HIGH ENERGY PHYSICS], JULY 1, 1970-JUNE 30, 1971. (Duke Univ., Durham, N. C.). Contract AT(40-1)-3065. 8p. Dep. NTIS.

Research on the RIPPLE program for bubble chamber measurements, development of the rapid-cycling bubble chamber, and high-energy hadron interaction experiments is summarized. A list of publications is included. (J.F.P.)

45627 (PPAR-24) SURVEY OF EXPERIMENTS RUN AT THE PRINCETON-PENNSYLVANIA ACCELERATOR, 1963-1971. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). 15 Jun 1971. Contract AT(30-1)-2137. 51p. Dep. NTIS.

Brief summaries are given of the research performed at the Princeton-Pennsylvania Accelerator during the period of its operation from 1963 to 1971. A graphical display of the research program and a list of Ph.D. theses prepared from this research are also included. (J.F.P.)

Electromagnetic

Refer also to abstracts 45540, 45693, and 45796.

45628 (AD-714022) HIGH-ENERGY ELECTRON SCATTERING FROM ^{6}Li. Li, G. C.; Sick, I.; Whitney, R. R.; Yearian, M. R. (Stanford Univ., Calif. High-Energy Physics Lab.). Jul 1970. Contract Nonr-225(67). 24p. (HEPL-636). NTIS.

Elastic electron scattering cross sections were measured for ^{6}Li at 500 MeV and values of q^2, the momentum transfer squared, up to 13 f (m^{-2}). Calculations including nucleon-nucleon correlations predict a diffraction minimum beyond the range of previous measurements for ^{6}Li. The results for ^{6}Li do show a diffraction minimum at $q^2 = 8$ f (m^{-2}); they are also compared with a phase shift calculation using an empirical charge distribution. (auth)

45629 (DESY-71/25) ELECTROPRODUCTION OF $\pi^+\Delta^0(1236)$ ON HYDROGEN. Driver, C.; Heinloth, K.; Hoehne, K.; Hofmann, G.; Karow, P.; Schmidt, D.; Specht, G.; Rathje, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1971. 33p. Dep. NTIS (U. S. Sales Only).

The electroproduction of a π^+-meson and of the $\Delta^0(1236)$ nucleon resonance on hydrogen, $e\,p \rightarrow e'\,\pi^+\Delta^0(1236)$, was investigated by measuring the scattered electron and the produced π^+-meson in coincidence. The differential cross sections as functions of s_0, q^2, $t\text{-}t_{min}$ or $\theta^+_{\pi q}$, and $\phi_{\pi q}$ were determined in a given kinematical region. (auth)

45630 (INR-1279) GROUPS OF PENETRATING PARTICLES IN EAS. Hibner, J.; Wysocki, S. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 11p. Dep. NTIS (U. S. Sales Only).

Among nearly 15,500 showers recorded by the underground Lodz-device, 24 cases of groups of penetrating particles were ascertained according to the criteria discussed and defined herein. At most 5 to 6 cases may be explained by means of known processes/interactions of nuclear-active particles or muons/, or by the gradient and statistical fluctuation of the muon density; the other groups 20 or nearly 20 seem to be muon bundles. (auth)

45631 PHOTOPRODUCTION OF NEUTRAL RHO MESONS. Ogren, Harold Olof. Ithaca, N. Y.; Cornell Univ. (1970). 180p. University Microfilms Order No. 71-14,582.

Thesis.

Rho photoproduction was measured from hydrogen, deuterium, and complex nuclei at photon energies from 4 GeV to 8.8 GeV. The dipion mass spectra over the mass range 450 MeV to 950 MeV from selected elements at photon energies 4.4 GeV, 6.5 GeV, and 8.8 GeV are fit using a Drell-type nonresonant pi pair background and its interference with the resonant rho amplitude and no other arbitrary backgrounds. Forward production angular distributions measured from hydrogen, deuterium and complex nuclei are characteristic of diffraction processes. However, the hydrogen and deuterium ratios at $t = 0$ indicate the presence of nondiffractive amplitudes for photon energies less than 6 GeV. The A-dependence of the cross sections measured from complex nuclei at energies 4.4, 6.1, 6.5, and 8.8 GeV are analyzed to yield values of $\gamma^2\rho/4\pi$, the rho-photon coupling constant, and $\sigma_{\rho N}$, the rho-nucleon total cross section. (Diss. Abstr. Int., B)

45632 PHOTOPRODUCTION OF PI PLUS MESONS FROM A POLARIZED PROTON TARGET AT 5 AND 16 GeV. Morehouse, Charles Conover. Berkeley, Calif.; Univ. of California (1970). 110p. University Microfilms Order No. 71-15,845.

Thesis.

Described is the measurement of the asymmetry in the cross section for the reaction $\gamma p \rightarrow \pi^+ n$ between the two states of polarization of the initial proton normal to the plane of scattering. The laboratory photon energies, k, were 5 and 16 GeV, and the regions of momentum transfer, t, covered were $0.14 \leq \sqrt{-t} \leq 1.01$ GeV/c and $0.14 \leq \sqrt{-t} \leq 0.78$ GeV/c respectively. A butanol polarized target was used with the SLAC 20 GeV/c magnetic spectrometer. The data show a sizeable asymmetry at both 5 and 16 GeV. The 16 GeV data peak at $\sqrt{-t} \sim 0.30$ GeV/c with an asymmetry of about -0.70, and 5 GeV data peak at $\sqrt{-t} \sim 0.80$ GeV/c with an asymmetry of about -0.70. (The direction of our normal to the scattering plane is along (photon in) × (pion out).) (Diss. Abstr. Int., B)

45633 SEARCH FOR POLARIZATION IN ELASTIC e^-p SCATTERING AT 15 AND 18 GeV. Powell, Thomas Mabrey. Berkeley, Calif.; Univ. of California (1970). 107p. University Microfilms Order No. 71-15,868.

Thesis.

The asymmetry was measured in the elastic scattering of electrons from a polarized proton target. An interference between the imaginary part of the two-photon-exchange amplitude and the one-photon-exchange amplitude could produce a polarization effect. The results indicate no asymmetry within the experimental accuracy of 1 to 2% at four-momentum transfer squared values of 0.38, 0.59, and 0.98 $(GeV/c)^2$. (Diss. Abstr. Int., B)

45634 TEST OF TIME REVERSAL INVARIANCE IN THE ELECTROMAGNETIC INTERACTIONS OF HADRONS: ASYMMETRY IN INELASTIC ELECTRON SCATTERING. Rock, Stephen Elliot. Berkeley, Calif.; Univ. of California (1970). 145p. University Microfilms Order No. 71-15,876.

Thesis.

The recent discovery of a violation of CP invariance has led to speculation on the origins and nature of the symmetry violating forces. This experiment is a search for this violation in the electromagnetic interactions of hadrons. A search was made for a violation of time-reversal invariance in inelastic electron scattering from a polarized proton target. A difference in cross sections (asymmetry) when the target was polarized in opposite directions along the normal to the scattering plane would mean either a time-reversal-invariance violation or a contribution from high order (α^3) effects. Data were taken using electron and positron beams to distinguish between the two possible causes of an asymmetry. Scattered electrons were detected in a magnetic spectrometer and the mass of the inferred out-going hadronic state was calculated. The target polarization was reversed frequently in order to facilitate comparison of cross sections and to cancel random errors. The background from heavy unpolarized nuclei only contributed to an overall normalization factor. This was determined by supplementary measurements with carbon and CH_2 targets. Data were taken at SLAC energies in the region of resonance excitation of the outgoing hadron and at values of four-momentum transfer squared of 0.4, 0.6, and 1.0 $(GeV/c)^2$. The experimental errors were as small as 1.5% in asymmetry at certain kinematic conditions. No sizable violation of time-reversal invariance was found. (Diss. Abstr. Int., B)

45635 COSMIC-RAY INTERACTIONS AT 10^{11} TO 10^{13} eV. Cowan, E. W.; Matthews, K. (California Inst. of Tech., Pasadena). Phys. Rev., D; 4: No. 1, 37-45(1 Jul 1971).

A sample of 1167 single cosmic rays near sea level is analyzed from the data recorded by an interleaved stack of cloud and ionization chambers, and carbon and iron plates. The results include loss-rate curves in iron and carbon, mean free path in carbon, and energy spectra of charged hadrons (largely pions) and neutrons. (auth)

45636 MEASUREMENT OF ASYMMETRY OF π^+-MESON PHOTOPRODUCTION UNDER LARGE ANGLES IN THE REGION OF THE FIRST RESONANCE. Kuznetsov, V. M.; Stukov, O. I.; Repenko, E. V.; (and others) (Tomsk Polytechnic Inst., USSR). Yadern. Fiz.; 13: No. 5, 1052-5(May 1971). (In Russian).

Techniques and the results are presented of measurements of the asymmetry of π^+-meson photoproduction by the linearly polarized photon beam for the angles of 51, 82, 106, 116, 133, and 134° at the photon energies in the region 210 to 270 MeV. (auth)

45637 K_1^0-K_2^0 MASS DIFFERENCE. Carnegie, R. K.; Cester, R.; Fitch, V. L.; Strovink, M.; Sulak, L. R. (Princeton Univ., N. J.). Phys. Rev., D: 4: No. 1, 1-6(1 Jul 1971).

XUM

The $K_1^0-K_2^0$ mass difference was measured by the "gap method" to high precision. This method is especially insensitive to possible systematic biases. The measurement yields $|\Delta M| = (0.534 \pm 0.007) \times 10^{10}$ sec^{-1}. Expressed in units of the inverse K_1^0 lifetime, $\tau_1 = 0.862 \times 10^{-10}$ sec, $|\delta| = 0.460 \pm 0.006$, or equivalently, 26.4° ± 0.3° per K_2^0 mean decay length. (auth)

45638 DETERMINATION OF THE SIGN OF THE $K_L^0 - K_S^0$ MASS DIFFERENCE. Hill, D. G. (Brookhaven National Lab., Upton, N. Y.); Sakitt, M.; Skejeggestad, O.; (and others). Phys. Rev., D; 4: No. 1, 7-16(1 Jul 1971).

The final results of an experiment to measure the sign of the $K_L^0 - K_S^0$ mass difference are presented. The sign was measured by studying the time distribution of scattered neutral K mesons, using K^0's from the reaction $K^+ + d \rightarrow K^0 + p + p$. We obtain $M_{K_L} > M_{K_S}$. (auth)

45639 SEA-LEVEL SEARCH FOR COSMIC MAGNETIC MONOPOLES. Fleischer, R. L.; Hart, H. R. Jr.; Nichols, G. E.; Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev., D; 4: No. 1, 24-7(1 Jul 1971).

On the hypothesis that the highest-energy cosmic rays consist at least in part of magnetic monopoles, heavily ionizing particles were sought at ground level using an 18-m^2 detector array exposed for 630 days. The observable flux of Dirac monopoles at ground level is less than 1.5×10^{-9}/m^2 sec sr with 95% confidence. Monopoles are not the dominant cause of air showers having energies up to 3.0×10^{16} eV. (auth)

45640 DIRECT PRODUCTION OF ELECTRON PAIRS IN NUCLEAR EMULSION BY 13.75-BeV ELECTRONS. Cary, Arthur S.; Barkas, Walter H.; Hart, Edward L. (Univ. of California, Riverside). Phys. Rev., D; 4: No. 1, 27-9(1 Jul 1971).

A measurement was made of the total cross section for direct production of electron pairs by 13.75-BeV electrons in nuclear emulsion. The result, $(4.03 \pm 0.36) \times 10^{-25}$ cm^2, is in good agreement with quantum electrodynamics. (auth)

45641 BACKWARD-ANGLE ELECTRON–PROTON ELASTIC SCATTERING AND PROTON ELECTROMAGNETIC FORM FACTORS. Price, L. E.; Dunning, J. R. Jr.; Goitein, M.; (and others) (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 4: No. 1, 45-53(1 Jul 1971).

Elastic electron-proton scattering cross sections were measured at backward angles (80°–90°) in the laboratory for four-momentum transfers between 7 F^{-2} and 45 F^{-2}. Experimental errors range from 3.1% to 5.3%, including a systematic error estimated to be 1.9% added in quadrature. Electric and magnetic form factors are computed from all the recent data in this q^2 range, with allowance made for possible normalization differences. The results show a deviation from the scaling law. (auth)

45642 PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 200 AND 440 MeV. I. MEASUREMENTS WITH A MAGNETIC SPECTROMETER. Fischer, G.; Fischer, H.; von Holtey, G.; (and others) (Univ., Bonn). Z. Phys.; 245: No. 3, 225-52(1971).

At the Bonn 500-MeV electron synchrotron the differential cross section of the reaction $\gamma + p \rightarrow \pi^0 + p$ was measured detecting the recoil proton by a magnetic spectrometer. Angular distributions between pion c.m. angles of 50 and 160° were taken at photon energies between 220 and 420 MeV. (auth)

45643 PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 200 AND 440 MeV. III. COMPARISON AND DISCUSSION OF THE TWO BONN MEASUREMENTS. Braunschweig, W.; Fischer, G.; Fischer, H.; (and others) (Univ., Bonn). Z. Phys.; 245: No. 3, 272-82 (1971).

The two measurements of the process $\gamma + p \rightarrow \pi^0 + p$ at the Bonn 500 MeV electron synchrotron are discussed and after correction of systematic deviations combined to one set of data. A comparison with other measurements and theoretical calculations is given. (auth)

45644 PHOTOPRODUCTION OF NEUTRAL PIONS ON HYDROGEN AT PHOTON ENERGIES BETWEEN 200 AND 440 MeV. II. MEASUREMENTS WITH A RANGE TELESCOPE. Braunschweig, W.; Genzel, H.;Wedemeyer, R. (Univ., Bonn). Z. Phys.; 245: No. 3, 253-71(1971).

Differential cross sections of the π^0-photoproduction on protons were measured with the photon beam o^r the 500 MeV-synchrotron at Bonn University by means of a range telescope. Using this experimental set-up it was possible to obtain data between photon energies from 200 to 440 MeV and intervals of pion angles in the cm system from 50 to 140°. In steps of 10° excitation curves were measured from ten to ten MeV photon energy. The resolution of the apparatus is characterized by a solid angle of 0.6 msterad and an energy width of about 10 MeV. Strong efforts were spent in evaluating the corrections and proving them by test runs; by this procedure it became possible to limit the systematical errors to values of 5% or lower with a statistical uncertainty of less than 3% in most cases. It was the aim of the experimental group to get a complete data set of differential cross sections over a large kinematical area around the first resonance with small errors for the possibility of tests of theoretical models. (auth)

45645 PHOTOPRODUCTION OF NEUTRAL RHO MESONS WITH LINEARLY POLARIZED PROTONS. McClian, Gene Elvin. Ithaca, N. Y.; Cornell Univ. (1971). 129p. University Microfilms Order No. 71-17,112.

Thesis.

The production of neutral rho (ρ^0) mesons by linearly polarized photons in the forward direction from carbon and hydrogen was measured in a counter experiment at the Cornell electron synchrotron. Linearly polarized photons are obtained from coherent bremsstrahlung by 9.7 GeV electrons striking a diamond crystal. With proper orientation of the crystal, a major peak is obtained in the photon energy spectrum between 3.0 and 4.0 GeV. The average linear polarization of the photon peak is about 65%. With this photon spectrum, data were taken from carbon nuclei at average photon energies from 2.5 GeV to 8.0 GeV and from protons at 3.5 GeV. The apparatus detects ρ^0 decay into $\pi^+\pi^-$ pairs that are nearly symmetric about the incident beam direction and near the horizontal plane. Diffractive production of ρ^0's gives the azimuthal decay angular distribution $\cos^2\phi$, where ϕ is the angle between the photon polarization plane and the ρ^0 decay plane. Nondiffractive production by "unnatural" parity exchange (e.g., elementary one-pion exchange) gives the distribution $\sin^2\phi$. The two processes are separated by measuring the cross sections $d\sigma_{||}$ and $d\sigma_{\perp}$ for $\phi = 0°$ and $\phi = 90°$, respectively. The asymmetry ratio $\Sigma \equiv (d\sigma_{||} - d\sigma_{\perp})/(d\sigma_{||} + d\sigma_{\perp})$ is calculated. The forward production cross section $d\sigma/dt_\rho(\theta = 0)$ from carbon is found to be nearly constant between 2.5 GeV and 8.0 GeV with the average value 8.85 ± 0.17 mb/GeV^2. The average asymmetry from 3.0 GeV to 4.0 GeV is $\Sigma_{carbon} = 1.00 \pm 0.04$. Both results are consistent with purely diffractive production from carbon. The asymmetry result shows that ρ^0 production from carbon is an excellent analyzer for measuring the polarization of high energy photons. The hydrogen measurement at 3.5 GeV gives the asymmetry result $\Sigma_{proton} = 0.91 \pm 0.07$. The value is consistent with purely diffractive production in the forward direction, but does not rule out a 5% to 10% nondiffractive component. (Diss. Abstr. Int., B)

Weak

Refer also to abstracts 45318, 45319, and 45869.

45646 (AD–716464) MEASUREMENT OF THE ANGULAR CORRELATION COEFFICIENT IN NEUTRON DECAY. Final Scientific Report, February 1, 1969–July 31, 1970. Weinzierl, Peter; Paul, Helmut (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). 20 Oct 1970. Contract F61052-69-C-0038. 13p. (AFOSR–70-2815-TR). NTIS.

The aim is to determine the angular correlation constant, and hence, the coupling constant ratio C sub A/C sub V, in neutron beta decay by measuring the shape of the proton recoil spectrum. Further preliminary investigations were done concerning the effect of neutron motion and finite spectrometer resolution upon the spectrum, on the optimization of the measurement cycle, and on the appearance of surface charges under electron irradiation. The beam tube insert and the vacuum system were assembled and tested. The magnetic shielding inside the beam tube was tested. The proton test source was finished. The proton detector was tested, and it was possible to reduce the background counting rate to a sufficiently low value. The control and data output system was finished and tested. An evaluation of coupling constants in beta decay using published data was done by means of a computer program. (auth) (USRDR)

45647 (LAL–1245) PCAC TESTS IN HIGH ENERGY NEUTRINO INTERACTIONS. Masnou, J. L. (Paris Univ., Orsay (France). Faculte des Sciences). Mar 1971. 131p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The experimental equipment used to produce neutrinos and to study their interactions is described. The way in which the interaction reactions were selected is discussed. A kinematic study of the previously selected reactions is presented so that the appropriate interaction associated with each event can be chosen and the interactions divided according to whether they are elastic or inelastic. The application of the partial conserva-

tion of axial current test (PCAC) to neutrino interactions is described and the results obtained from the π^+ photographs taken in the propane-filled BP 3 bubble chamber given. The PCAC test was conducted in the following manner: the experimental distribution in q^2 for inelastic interactions is compared to that theoretically calculated; the upper limit to q^2 is determined from these data; theoretical and experimental distributions in M_β^2 and Cos $\Theta_{\mu\nu}$ for events having a q^2 value less than this limit are compared; multiplicities of β systems in the interactions of neutrinos and π^+ are compared. The large effect of the transverse contribution does not allow conclusions to be drawn on the validity of the PCAC from these multiplicity results. (France)

45648 ENERGY AND ANGULAR DISTRIBUTION OF MUONS OF ENERGY 3 TO 10 TeV ACCORDING TO EMULSION-STACK DATA. Baradzei, L. T.; Kanevskaya, E. A.; Smorodin, Yu. A.; Solov'ev, M. V. (Moscow Inst. of Physics). Kratk. Soobshch. Fiz.; No. 12, 67-75(Dec 1970). (In Russian).

An emulsion stack of x-ray film was used to record an electron-photon cascade initiated by bremsstrahlung from the muons. The energy of the latter is measured by photometric comparison of the spot density on the film, and the angle of incidence is indicated by the spot displacement throughout the emulsion layers with an accuracy of 3°. A discussion of this technique is presented, based upon experimental and calculated data. (K.S.W.)

45649 MUONS PRODUCED BY ATMOSPHERIC NEUTRINOS: EXPERIMENT. Reines, F. (Univ. of California, Irvine); Kropp, W. R.; Sobel, H. W.; (and others). Phys. Rev., D; 4: No. 1, 80-98(1 Jul 1971).

The interaction of high-energy muon neutrinos produced in the atmosphere by primary cosmic rays was observed deep underground (8.74×10^5 g cm^{-2} std. rock) in the rock surrounding a large-area (160 m^2) liquid-scintillation-detector hodoscope. A series of arguments is given to separate the residual atmospheric muons which reached the detector from those produced by neutrino interactions in the surrounding rock. These arguments are based on the widely differing angular distributions and mean energies of the two sources. The observation of four events arising from the decay of muons stopping in the detector suggests that the energy of neutrino-induced muons is ~½ GeV. Operation of the system over a three-year period yielded a total of 39 which is identified as neutrino-produced muons. Of these, 35 were in the aperture chosen for the observation of neutrino-induced muons, yielding a total rate of $(6.5 \pm 1.1) \times 10^{-7}$ sec^{-1}. In a companion paper, this result is compared with rates predicted using various theoretical models of the neutrino-nucleon interaction. This comparison selects the most appropriate model and leads to an underground neutrino-induced muon flux. The simplifying approximation of an isotropic neutrino distribution leads directly to a flux of $(3.7 \pm 0.6) \times 10^{-13}$ cm^{-2} sec^{-1} sr^{-1}. (auth)

45650 MUONS PRODUCED BY ATMOSPHERIC NEUTRINOS: ANALYSIS. Chen, H. H.; Kropp, W. R.; Sobel, H. W.; Reines, F. (Univ. of California, Irvine). Phys. Rev., D; 4: No. 1, 99-121 (1 Jul 1971).

The experimental rate of muons produced deep underground by neutrinos is used together with neutrino cross sections from experiments at CERN and the atmospheric-neutrino spectrum as determined from cosmic-ray-muon data, to deduce the high-energy (>10 GeV) behavior of neutrino cross sections. A cutoff parameter M_W is used to limit the linear increase of the inverse-β-reaction cross section with energy which would otherwise result from scale invariance. A comparison (neglecting uncertainties) of the calculated and the experimentally determined muon rates shows a deviation from linearity that would be observable at a neutrino lab energy of ~50 GeV. If the hypothetical W boson of weak interactions provides the mechanism for this saturation, then a (weak) upper limit can be set on its mass. At 1 standard deviation, this limit is $M_W \leq 45$ GeV/c^2. Should the W boson exist, it can also be produced copiously if it has sufficiently small mass. Thus a lower limit on its mass can also be set. At 1 standard deviation, this limit is $M_W \gtrsim 2.9$ GeV/c^2, where this limit is independent of W decay modes. More accurate accelerator-neutrino (antineutrino) experiments at energies up to 10 GeV and an improvement in our knowledge of the underground muon rate could reduce significantly the spread between the upper and lower limits on M_W. The underground results are also used to set limits on neutrino fluxes from extraterrestrial sources, e.g., for a saturation energy of ~60 GeV, the 1-standard-deviation upper limit on an extraterrestrial-neutrino flux is ~½ of the atmospheric-neutrino flux. (auth)

45651 POLARIZATION OF COSMIC-RAY MUONS. Turner, R. (Yale Univ., New Haven); Ankenbrandt, C. M.; Larsen, R. C. Phys. Rev., D; 4: No. 1, 17-23(1 Jul 1971).

The polarization of cosmic-ray muons arriving at sea level with different energies and from different zenith angles was measured. The polarization of positive muons from the zenith with energies near 1.0 GeV was found to be -0.33 ± 0.04, where the polarization in the direction of flight was measured and the negative sign indicates that the spin was antiparallel to the direction of flight. Muons from the zenith with energies near 3.5 GeV at sea level had polarizations of -0.38 ± 0.04, and the polarization of muons with energies near 4.5 GeV incident at an angle of 45° with the zenith was found to be -0.34 ± 0.04. These polarizations are consistent with the polarizations calculated on the basis that the muons are derived almost wholly from the decay of pions produced by the interaction of primary and secondary cosmic-ray hadrons with the nuclei of the atmosphere. (auth)

45652 LIMITS ON THE $K^+ \to \pi^+ + \nu + \bar{\nu}$ AND $K^+ \to \pi^+ + n\gamma$ DECAY RATES. Klems, J. H. (Univ. of Chicago); Hildebrand, R. H.; Stiening, R. Phys. Rev., D; 4: No. 1, 66-80(1 Jul 1971).

The branching ratio for the process $K^+ \to \pi^+ + \nu + \bar{\nu}$ is shown by a counter–spark-chamber experiment to be less than 1.4×10^{-6} of all decay modes, assuming a pion energy spectrum like that of $K^+ \to \pi^0 + e^+ + \nu$. The apparatus was sensitive to pions in the kinetic-energy range 117–127 MeV. For the same energy interval a limit of 5×10^{-6} is established for the process $K^+ \to \pi^+ + \gamma + \gamma$, assuming a phase-space model for the decay. A limit of 4×10^{-6} is established for the process $K^+ \to \pi^+ + \gamma$. (auth)

45653 MEASUREMENTS OF THE BRANCHING RATIO $\Gamma(K_L \to 2\gamma)/\Gamma(K_L \to 3\pi^0)$. Barmin, V. V.; Barylov, V. G.; Veselovskii, G. S.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 35B: No. 7, 604-5(19 Jul 1971).

Using the 180-liter ITEP liquid xenon bubble chamber the branching ratio $\Gamma(K_L \to 2\gamma)/\Gamma(K_L \to 3\pi^0)$ was measured to be $(2.13 \pm 0.43) \times 10^{-3}$. (auth)

45654 PROPOSED EXPERIMENTAL TEST OF NEUTRINO SEA AS A SUBQUANTIC MEDIUM. Dudley, H. C. (Univ. of Illinois, Chicago). Nuovo Cim., 4B: No. 1, 68-72(11 Jul 1971).

Astrophysical findings coupled with known properties of a generalized neutrino-antineutrino flux suggest that there exists a finite medium which may be capable of transmitting electromagnetic radiation. Recent theoretical studies support this hypothesis. Previous studies of "ether drift" centered attention on earth's orbital motion (30 km/s), largely ignoring galactic velocity (220 km/s). A critical experimental test using high-velocity emitters with flows parallel to the earth's galactic motion is suggested. (auth)

45655 MUON INTENSITIES UNDERGROUND ((50 TO 4300) mwe) AND THE S. L. ENERGY SPECTRUM. Bergamasco, L. (CNR, Turin); Piazzoli, B. d'Ettorre; Picchi, P. Nuovo Cim., 4B: No. 1, 59-67(11 Jul 1971).

Some experimental results on the muon intensities at shallow depths ((50 to 240) m w.e.) and at great depth (4300 m w.e.) are reported. The data at lower energies ($E \leq 10^2$ GeV) compared with the conventional energy spectrum and the bubble chamber spectrum are in agreement with the first one. In the (1 to 10) TeV region the intensity-depth curve derived gives a value for the integral spectrum index $\gamma = 2.7$, in good agreement with the burst data. (auth)

Strong (Baryon-Induced)

Refer also to abstract 45892.

45656 (FRNC-TH-28) PROTON–NUCLEI AND ANTIPROTON–NUCLEI INTERACTIONS AT 3 GeV/c IN IONOGRAPHIC EMULSIONS. Brou, Rene (Caen Univ. (France)). 1970. 108p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Parameters of the optical model (Ro = 1.37 ± 0.10 Fermi; Vo = 23 ± 8 MeV; W = 32 ± 10 MeV) determined from small angle elastic scattering studies lead to a contradiction in the values obtained for the absorption cross sections for antiprotons by complex nuclei. In contrast, the values obtained for the absorption of protons are correctly predicted. Cross sections for the production of pions in the antiproton–proton reactions agree with results obtained in bubble chambers. The annihilation radius obtained from the application of the statistical model to average nuclei of the emulsion indicates a high probability of annihilation at the periphery of the nucleus. The distinctive character of the fine traces, their angular distribution and the parameters from the Steenberg model were compared for the interactions of protons and antiprotons. Annihilation cross sections were determined experimentally for the light nuclei C, N, and O and for the heavy

XUM

nuclei Ag and Br; the values obtained were compared with those calculated from the Steenberg model. Annihilations occur in 70 percent of the cases with heavy nuclei. (France)

45657 (NEVIS–186) STUDY OF THE ANNIHILATIONS OF ANTIPROTONS AT REST IN HYDROGEN INTO THREE NEUTRAL PIONS. Kozlowski, Thomas (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1971. Contract AT(30-1)-1932 Task I. 142p. (CU–290; R–745). Dep. NTIS.

Thesis.

The annihilation of antiprotons at rest into three neutral pions was studied as part of an experiment to study the neutral channels of antiproton–proton annihilations. The 6 γ rays from annihilations into $3\pi^0$ were detected by a system of large, steel plate, γ converting, optical spark chambers. The γ ray energies were deduced from the measured angles of the γ showers and the hypothesis that they came from the process $\bar{p} + p \rightarrow 3\pi^0 \rightarrow 6\gamma$. A final sample of 1298 events containing about 75% true $3\pi^0$ events was used in the analysis. The rate for annihilations at rest into $3\pi^0$ relative to all channels was found to be $(0.49 \pm 0.19) \times 10^{-2}$. Various theoretical amplitudes, including coherent Breit Wigner forms and Veneziano model amplitudes, were compared to the data. The data are consistent with the presence in the $3\pi^0$ events of the $\epsilon^0(J^P = O^+)$ and $f^0(J^P = 2^+)$ two-pion resonances. (auth)

45658 $\bar{p}p$ ELASTIC SCATTERING IN THE T-MESON REGION. Kalbfleisch, G. R.; Strand, R. C.; Vanderburg, V. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; B30: No. 2, 466-76(1971).

Improved measurements of 43.8 ± 0.8, 41.3 ± 0.4 and 39.3 ± 0.8 mb were made for the $\bar{p}p$ elastic cross sections at 1.11, 1.33 and 1.52 GeV/c laboratory momenta, respectively. Sharp forward peaks in the differential cross sections with broad secondary maxima agree with previous observations. The forward differential cross sections are (11 ± 3)% above the optical point in agreement with real amplitudes extended from lower momenta using dispersion relations. The elastic cross sections do not show any structure in the s-channel. Backward differential cross sections show the onset of a "third diffraction peak" but no evidence for other structure in agreement with earlier experiments. (auth)

45659 ANALYSIS OF THE ANNIHILATION PROCESS $\bar{p}p \rightarrow \pi^+\pi^-\omega$ AT REST USING VENEZIANO-TYPE AMPLITUDES. Chung, S. U.; Montanet, L.; Reucroft, S. (CERN, Geneva). Nucl. Phys.; B30: No. 2, 525-34(1971).

An analysis of $\bar{p}p \rightarrow \pi^+\pi^-\omega$ at rest is presented using Veneziano-type amplitudes involving the ρ-, f- and B-trajectories to represent the $^1S_0$ and $^3S_1$ initial states of the annihilation. A reasonable fit is obtained which gives a good description of the Dalitz plot as well as the ω-decay angular distributions. It is shown that most of the discrepancy between fit and experiment is at the high $\pi\pi$ effective mass. (auth)

45660 ANNIHILATION PROCESS $p\bar{p} \rightarrow 2\pi^+2\pi^-\pi^0$ AT 2.5 GeV/c. Clayton, J. (Univ. of Liverpool); Mason, P.; Muirhead, H.; (and others). Nucl. Phys.; B30: No. 2, 605-16(1971).

Substantial production of the resonances ρ, f and ω was observed in this reaction. In contrast with the channel $p\bar{p} \rightarrow 2\pi^+2\pi^-$, associated production of resonances was found to occur. The behavior of the associated production of ω-mesons with other resonances is shown to be consistent with some very simple assumptions. Alternative methods of displaying data for $p\bar{p} \rightarrow \pi\pi\omega$ are discussed; it is shown that the longitudinal phase plot for this reaction is unlike that obtained for any previously reported reaction. Reasonable agreement for the behavior of this channel is found with the multiperipheral model of Chan, Łoskiewicz and Allison. (auth)

45661 STUDY OF THE REACTION $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ AT AN ANTIPROTON MOMENTUM OF 2.5 GeV/c. Mason, P. (Univ. of Liverpool); Muirhead, H.; Poppleton, A. (and others). Nucl. Phys.; B30: No. 2, 617-33(1971).

A study of 802 events of the type $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ at an incident $\bar{p}$ momentum of 2.5 GeV/c, obtained in the CERN 2 m hydrogen bubble chamber, was made. There is abundant associated $\Delta\bar{\Delta}$ isobar production of a peripheral nature which cannot be adequately described by a one-pion-exchange (OPE) model alone. However, after allowing for the effect of an enhancement at a $\Delta\pi$ mass of 1370 MeV/c^2 in ≈43% of the events, the remaining events were satisfactorily described by the OPE model with absorption. It is shown that this enhancement may be interpreted as either a resonance or an S-wave scattering effect. A discussion is given explaining why this conclusion is not in agreement with the work of other groups who studied the same reaction at nearby energies. (auth)

45662 FOUR-MOMENTUM TRANSFERRED BETWEEN GROUPS OF SECONDARY PARTICLES IN THE INTERACTIONS OF NUCLEONS AND HEAVY NUCLEI OF COSMIC RAYS IN EMULSION. Alekseeva, K. I. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 13: No. 5, 1062-8(May 1971). (In Russian).

The lower bound of the 4-momentum transferred between groups of secondary particles in jets with large multiplicity produced by nucleons and heavy nuclei of cosmic rays is estimated. It is shown, that the 4-momentum transferred in jets is proportional to the multiplicity of the jet. It is shown that the value of the 4-momentum transferred per one elementary NN interaction inside the nucleus-target gives $\langle\Delta_{||}^{NN}\rangle = 1.30 \pm 0.09$ GeV/c. (auth)

45663 COSMIC-RAY STUDY OF PROPERTIES OF NUCLEAR INTERACTIONS IN THE 10 TO 300-GeV ENERGY RANGE. Goza, E. R.; Huggett, R. W.; Jones, W. V.; Stafford, E. G. (Louisiana State Univ., Baton Rouge). Phys. Rev., D; 4: No. 1, 30-6(1 Jul 1971).

A balloon-borne apparatus consisting of an emulsion target, spark chambers, and an ionization spectrometer was used to study properties of nuclear interactions of cosmic rays in the energy range 10 to 300 GeV. The ionization spectrometer, used to measure the energies E_{sp} of the primaries passing through the apparatus, was calibrated at accelerator energies. This calibration was extrapolated to higher energies using Monte Carlo calculations. A comparison of energy estimates obtained using emulsion methods with E_{sp} indicates that for proton interactions the method based on constancy of transverse momentum and inelasticity gives an energy $1.5E_{ch}$ that is too large by a factor of only 1.1 ± 0.2, whereas the method of Castagnoli gives an energy E_{Cast} that is too large by a factor of 5 ± 2. For interactions of Z > 1 primaries, estimates (E_p and E_α) based on the opening angle of fragments and the 1.5 E_{ch} estimates are in good agreement with E_{sp}. It is found that if the depth of the first interaction of each primary is known to within ±¼ interaction length, the spectrometer estimate is not sensitive to some other characteristics of the first interaction, such as number and angular distribution of charged secondary particles. For proton interactions with fewer than six black and gray tracks, $E_{sp}^{¼}$ and lnE functions give better fits to the data on the mean number of minimum-ionizing secondaries vs $\langle E_{sp}\rangle$ than the $E^{¼}$ function does. (auth)

45664 ANTIPROTON–DEUTERON ELASTIC SCATTERING BETWEEN 1.60 AND 2.00 GeV/c. Ma, Z. Ming; Smith, G. A. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 27: No. 6, 344-7(9 Aug 1971).

Antiproton–deuteron elastic scattering between 1.60 and 2.00 GeV/c incident momenta was studied. The differential cross sections may be characterized by a very steep forward peak (with b ~ 43 GeV^{-2}) and a prominent break near $-t \sim 0.2$ GeV^2. The results are used to test the validity of Glauber's multiple-scattering theory. Within the experimental range of measurements ($-t$ between 0.028 and 0.46 GeV^2), the theory provides a good qualitative description of the data. (auth)

45665 COHERENT AND STRANGE PARTICLE PRODUCTION IN $\bar{p}d$ INTERACTIONS AT 7.0 GeV/c. Carson, Robert Gene. Baltimore; Johns Hopkins Univ. (1970). 175p. University Microfilms Order No. 71–16,714.

Thesis.

A study was made of the coherently produced four-prong states (1) $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-$ and (2) $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-\pi^0$ and numerous two- and four-prong states with associated vees from interactions of 7.0 GeV/c antiprotons with deuterium. Both states (1) and (2) exhibit strong $\bar{\Delta}^{--}(1240)$ production plus a prominent d^{+++} enhancement near 2200 MeV in the π^+d effective mass. The cross sections for states (1) and (2) and their sub-states with $\bar{\Delta}^{--}$ production and the d^{+++} enhancement are calculated for final deuteron momenta greater than 140 MeV/c; the mass range for the d^{+++} is taken between 2100 and 2260 MeV, but no background subtraction is imposed on the d^{+++} cross sections. The results are $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-$ 260 μb, $\bar{p}d \rightarrow \bar{\Delta}^{--}\pi^+d$ 185 μb, $\bar{p}d \rightarrow \bar{p}\pi^-d^{+++}$ 55 μb, and $\bar{p}d \rightarrow \bar{\Delta}^{--}d^{+++}$ 45 μb, and $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-\pi^0$ 180 μb, $\bar{p}d \rightarrow \bar{\Delta}^{--}\pi^+d\pi^0$ 110 μb, $\bar{p}d \rightarrow \bar{p}\pi^-d^{+++}\pi^0$ 55 μb, and $\bar{p}d \rightarrow \bar{\Delta}^{--}d^{+++}\pi^0$ 40 μb. The d^{+++} decay angular distribution is found to be quite asymmetric, ruling out the d^{+++} as a true resonance. Employing OPE and Reggeized pion models, including a parameterization of on-mass-shell pion deuteron elastic scattering, the d^{+++} is shown to be consistent with its interpretation as a kinematic effect. Cross sections are calculated for all decay modes for the numerous strange particle states and each is found to be less than 50 μb; no strong resonance production other than $K^*(890)$ and $\bar{\Delta}(1240)$ was observed. (Diss. Abstr. Int., B)

Strong (Meson-Induced)

Refer also to abstracts 45736 and 45741.

45666 (IFVE-SEF–69-87) TOTAL CROSS SECTION OF INTERACTIONS OF π^--, K^--MESONS AND ANTIPROTONS WITH

PROTONS AND DEUTERONS AT MOMENTA FROM 20 TO 65 GeV/c. Allabi, Dzh. V.; Bushnin, Yu. B.; Gorin, Yu. P.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

An experiment measuring the total cross sections for π^-, K^-, and $\bar{p}$ interactions with protons and deuterons using the IHEP 70-GeV accelerator is described. The standard method of transmission counters was used for the measurements. (C.E.S.)

45667 (JINR-E1-5847) COMPILATION OF DATA ON THE REAL PARTS OF THE $\pi^{\pm}p$ FORWARD SCATTERING AMPLITUDES. Dumbrais, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 19p. Dep. NTIS (U. S. Sales Only).

A compilation of experimentally determined values of the real parts of the $\pi^{\pm}p$ forward scattering amplitudes is given in a form in which these data may be used directly in analyses of forward dispersion relations. (auth)

45668 (UCRL-20678) PION-NUCLEON SCATTERING: EXPERIMENTS AND PHASE SHIFTS. Steiner, Herbert M. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr 1971. Contract W-7405-eng-48. 23p. (CONF-710433-1). Dep. NTIS.

From Conference on hadron phenomenology; Pasadena, Calif. (25 Apr 1971).

A short summary of some recent developments in pion-nucleon scattering experiments and phase shift analyses is presented. Several recent high quality experiments indicate that existing phase shift solutions do not give adequate fits to the data. Some attempts to extend phase shift analyses to higher energies are described. (auth)

45669 SINGLE AND DOUBLE DISSOCIATION IN π^-p COLLISIONS AT 11 AND 16 GeV/c. Kittel, W.; Ratti, S.; Van Hove, L. (CERN, Geneva). Nucl. Phys.; B30: No. 2, 333-73(1971).

The reactions $\pi^-p \to 2\pi^-\pi^+p$, $\pi^-p \to 2\pi^-\pi^+\pi^0p$ and $\pi^-p \to 2\pi^-2\pi^+n$ are analyzed at 11 and 16 GeV/c using longitudinal phase space (LPS) plots. The weighted LPS distribution for $\pi^-p \to 2\pi^-\pi^+p$ is dominated by two well separated structures corresponding to single diffraction dissociation of the pion, $\pi^-p \to (2\pi^-\pi^+)p$, and of the proton, $\pi^-p \to \pi^-(\pi^-\pi^+p)$. The former is more abundant than the latter, and both are approximately constant with energy. In contrast, processes of type $\pi^-p \to (2\pi)(\pi p)$ decrease with increasing energy. In the five-body reactions the weighted LPS distribution reveals especially at 16 GeV/c a maximum for single dissociation of the proton into $3\pi p$, namely $\pi^-p \to \pi^-(\pi^-\pi^+\pi^0p)$; this process is likely to be diffractive. The neutron channel has a corresponding maximum displaced toward a multiperipheral configuration $\pi^-p \to \pi^-(\pi^-2\pi^+)n$. Another strong maximum corresponds to the pion dissociation $\pi^-p \to (2\pi^-\pi^+\pi^0)p$. This is interpreted to be an ω-exchange process because no analogous structure occurs in $\pi^-p \to (2\pi^-2\pi^+)n$. Finally, a broad structure reveals double dissociation of both incident particles; it occurs in the two channels $\pi^-p \to (2\pi^-\pi^+)(\pi^0p)$ and $\pi^-p \to (2\pi^-\pi^+)(\pi^+n)$, being stronger in the latter. Further analysis of this process in terms of isospin exchange suggests that it is partially diffractive. Factorization is also discussed. An appendix gives general aspects of the LPS analysis for the asymptotic study of n-body collisions at very high energy. (auth)

45670 DECAY ASYMMETRY IN THE $\overline{K}^0\pi^-$ SYSTEM. Schreiner, P. A. (Univ. of California, Los Angeles). Nucl. Phys.; B30: No. 2, 374-80(1971).

A decay asymmetry in the $\overline{K}^0\pi^-$ system is observed in the reactions $K^-p \to \overline{K}^0\pi^-p$ and $K^-p \to \overline{K}^0\pi^-\Delta^+$ at 3.3 GeV/c. The effects are found to be present at only very small production angles. The data are compared with the Lovelace-Veneziano model for $K\pi$ scattering and qualitative agreement is obtained. (auth)

45671 EXPERIMENTAL CHARACTERISTICS OF THE CHARGE-EXCHANGE K^0 PRODUCING REACTIONS IN K^+p AND K^-p INTERACTIONS. Beaupre, J. V. (Technische Hochschule, Aachen); Deutschmann, M.; Graessler, H.; (and others). Nucl. Phys.; B30: No. 2, 381-97(1971).

A study is made of the charge-exchange reactions $K^+p \to K^0X^{++}$ at 5 and 8.2 GeV/c and $K^-p \to \overline{K}^0X^0$ at 10.1 GeV/c, where X denotes the system of all secondary particles different from K^0, with effective mass M. In general it is found that the production properties of the K^0 and of the X system are similar for incident K^+ and K^- mesons. The cross section for K^0 production is $\approx 40\%$ of the total inelastic Kp cross section in all cases studied. The mass spectrum of X, $d\sigma/dM$, outside the resonance region, increases exponentially with M, while the $d\sigma/dt'$ distributions decrease exponentially as $\exp(-At')$ for $0 < t' < 1.0$ GeV^2, with the value of A depending on the mass M as $M^{-\alpha}(\alpha \approx 2)$. The scaling effect predicted by Feynman is observed for the distributions of $x = p_L^*/p_{Lmax}^*$ in the K^+p reactions at 5 and 8.2 GeV/c. It is shown that a simple two-dimensional parametrisation in terms of M and t' can describe satisfactorily most of the experimental results. (auth)

45672 MEASUREMENT OF THE MUONIC DECAY OF PHOTOPRODUCED PHI MESONS. Keizer, Alan Stanley. Ithaca, N. Y.; Cornell Univ. (1970). 98p. University Microfilms Order No. 71-13,807.

Thesis.

An experiment was performed to measure the yield of muon pairs due to the decay of photoproduced phi mesons. An iron absorber pair telescope was employed which accepted muon pairs over a substantial range of pair invariant mass and momentum transfer to the carbon target nucleus. Also observed in this experiment were the yields of muon pairs due to the Bethe-Heitler process and decay of the rho and omega mesons. The phi yield was extracted from the total yield by a fitting procedure which relied on the sharply peaked pair invariant mass spectrum of the phi yield. The product of the muon branching ratio of the phi and the $t = 0$ photoproduction cross section from carbon was found to be $(0.66 \pm 0.10) \times 10^{-4}$ mb/GeV^2. This number is inconsistent with existing measurements of the branching ratio and the photoproduction cross section. (Diss. Abstr. Int., B)

45673 RESONANCE PRODUCTIONS IN K^+p INTERACTIONS AT 4.6 AND 9 GeV/c. Fu, Chumin. Berkeley, Calif.; Univ. of California (1970). 136p. University Microfilms Order No. 71-15,762.

Thesis.

A study is made of the reaction $K^+p \to K^+\pi^-\pi^+p$ at 9 and 4.6 GeV/c. The Brookhaven National Laboratory 80-inch hydrogen bubble chamber was employed for both experiments. It is found that one-pion exchange (OPE) plays a very important role in both the $K^0_{890}\Delta^{++}_{1236}$ and the $K^0_{1420}\Delta^{++}_{1236}$ double resonance productions and the low $\Delta^{++}_{1236}\pi^-$ mass enhancement in the $K^+\pi^-\Delta^{++}_{1236}$ channel. The decay properties of the double resonance channels indicate that OPE dominates over a larger t range in the lower energy (4.6 GeV/c) data than in the higher energy (9 GeV/c) data. In the small $K^+\pi^-$ mass region [$M(K^+\pi^-) < 1.54$ GeV], the contribution from the nonpion exchange is not negligible for $|t'| \gtrsim 0.05$ (GeV/c)^2 at 9 GeV/c and $|t'| \gtrsim 0.3$ (GeV/c)^2 at 4.6 GeV/c. It becomes more important as $|t'|$ increases. Thus a $K\pi$ scattering analysis can be performed only in a region where the $|t'|$ values lie below these limits. A mass peak at ~1.1 GeV in the $K^+\pi^-$ mass spectrum is observed in the large $|t'|$ region [$|t'| \geq 0.05$ (GeV/c)^2] in the $K^+\pi^-\Delta^{++}_{1236}$ channel at 9 GeV/c. Presumably it is produced mainly via nonpion exchange. The low $\Delta^{++}_{1236}\pi^-$ mass enhancement can be described by a double peripheral model. The dominant mechanism is a Pomeron and a pion (P,π) double Regge-pole exchange. The model gives good agreement with the data provided that both $-t_{K^+\to K^+}$ and $-t_{p\to\Delta^{++}}$ are less than 0.5 (GeV/c)^2 and $M(K^+\pi^-) \geq 1.54$ GeV. Problems involved with the extrapolation into the small $K^+\pi^-$ mass region are discussed. The importance of the contribution from the extrapolation and its implication to the $K\pi$ scattering analysis are also investigated. (Diss. Abstr. Int., B)

45674 STRANGE PARTICLE PRODUCTION IN π^+p INTERACTIONS NEAR 3.7 GeV/c. Butler, William Ralph. Berkeley, Calif.; Univ. of California (1970). 80p. University Microfilms Order No. 71-15,738.

Thesis.

Cross sections are presented for both stable and resonant strange particle final states produced by the interactions of positive pions in hydrogen. The data are taken from several incident momenta between 3.56 and 3.82 GeV/c. The overall strange particle cross section is found to be about 1.5 mb. Two favorable tests of line reversal by comparing are presented $\pi^+p \to Y^+K^+$ with $K^-p \to Y^+\pi^-$, where Y^+ first represents Σ^+ and then $\Sigma(1385)^+$. In a detailed study of the final state $p\pi^+K\overline{K}$, it is found that: $\sigma(\pi^+p \to p\pi^+\varphi) = 10 \pm 3$ μb, but $\sigma(\pi^+p \to \Delta^{++}\varphi) \leq 2$ μb; both the Δ^{++} and the $K^*(890)$ are prominent structures in this four-body final state; the $K\overline{K}$ state occurring with the Δ^{++} is either K_1K_1 or K^+K^- in even parity angular momentum states; however no threshold enhancement is associated with the Δ^{++}. (Diss. Abstr. Int., B)

45675 SELECTED K^-p REACTIONS AT 3.3 GeV/c. Schreiner, Philip Allen. Los Angeles; Univ. of California (1970). 225p. University Microfilms Order No. 71-16,360.

Thesis.

A study was made of selected K^-p reactions at a beam momentum of 3.3 GeV/c. The CERN two-meter liquid-hydrogen bubble chamber was employed to photograph the interactions. Events of the zero-prong, two-prong, and four-prong topologies with an associated vee were scanned for, measured on SMP's, and processed with the computer programs TVGP and SQUAW. Cross sections are determined for twenty-seven final states; the results range from 4μb to 1700μb. The techniques developed to adjudicate am-

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biguities between different final states are discussed in detail. Estimates are made of contamination and loss in the event samples. Detailed analyses are performed for the reactions $K^-p \to \overline{K}^0\pi^-p$, $K^-p \to \overline{K}^0\pi^-\Delta^+$, $K^-p \to \Lambda K^+K^-$, and $K^-p \to \Lambda\pi^+\pi^-$. Effective mass spectra, c.m. production angular distributions, Dalitz plots, and Chew-Low plots are displayed; resonance structure and the associated angular peripheralism are discussed. For reactions (1) and (2), the decay angular properties of the $\overline{K}^0\pi^-$ system are investigated as a function of its invariant mass; a comparison is made with the Lovelace model for $K\pi$ scattering and qualitative agreement is found. For $K^*(890)$ production in (1) and (2), density matrix elements are calculated. In addition, the production properties of the $\phi(1020)$ in reaction (3) are examined and the complete correlated $\Lambda\phi$ density matrix is evaluated. For reaction (4), the decay angular characteristics of the $\pi^+\pi^-$ system are investigated. A determination is made of the Y^{*+} (1385) density matrix and it is compared with prediction of the additive quark model; the agreement is excellent. The possibility of exotic meson exchange in $Y^{*-}(1385)$ production is explored and no positive evidence for such an effect is found. The five-particle generalization of the Veneziano model is compared with reaction (1), (3), and (4); good descriptions of much of the data are obtained. Both natural and unnatural spin-parity coupling are included for the $p\bar{p}$ and $\Lambda\bar{p}$ systems. Exchange-degeneracy properties of the K^* and Δ Regge trajectories are examined in (1); for reaction (3), the consistency of the Veneziano and dual quark models is established. Successful fits to reaction (4) are obtained by modifying the Veneziano amplitude's vector kinematic factor. (Diss. Abstr. Int., B)

45676 PION–PROTON ELASTIC SCATTERING NEAR 180^0 FROM 2.15 TO 6.00 GeV/c. Meanley, Edward Scripps. Ann Arbor, Mich.; Univ. of Michigan (1970). 392p. University Microfilms Order No. 71-15,237.

Thesis.

The execution, analysis, and results of a π^-p backward elastic scattering experiment are described. Differential scattering cross sections, which fall in the range of $\cos\theta_{CM}$ from −.94 to −1.00, are given at eleven beam momenta from 2.15 to 6.0 GeV/c. Optical spark chambers and a momentum spectrometer were used to observe the backward pion and to determine the missing mass of the other reactants. The data at 2.15, 2.50, and 2.80 GeV/c show considerable structure in the differential cross sections—in that range of beam momentum, the cross sections near 180^o change from a steep dip at 2.15 GeV/c to a sharp peak at 2.80 GeV/c. At 2.15 GeV/c the cross section falls from its peak at $\cos\theta_{CM} = -.96$ by a factor of 20 to the 180^o cross section of another experiment. The 2.80 GeV/c data fit well to $d\sigma/du = Ae^{Bu}$ with $B = 13.0 \pm 1.8$ $(GeV/c)^{-2}$. The data from 3.5 to 6.0 GeV/c provide primarily energy dependent information. They show that direct channel resonances probably contribute significantly to the cross sections as high in beam momentum as 5 GeV/c. With this study a survey of all backward elastic π^-p scattering data is presented. (Diss. Abstr. Int., B)

45677 RESONANCE PRODUCTION IN $p\pi^+\pi^-$ SYSTEM IN REACTION $\pi^-p \to p\pi^+\pi^-\pi^-$ AT 4.45 GeV/c. Beketov, G. V.; Zombkovskii, S. M.; Konovalov, B. S.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 5, 1056-61(May 1971). (In Russian).

Effective mass distribution of the $p\pi^+\pi$ system from reaction $\pi^-p \to p\pi^+\pi^-\pi^-$ at 4.45 GeV/c was studied using a 50 cm liquid-hydrogen bubble chamber. The characteristics of the isobars with masses ~1460 and ~1690 MeV were investigated. (auth)

45678 SEARCH FOR IONIZING TACHYON PAIRS FROM 2.2-GeV/c K^-p INTERACTIONS. Danburg, Jerome S. (Brookhaven National Lab., Upton, N. Y.); Kalbfleisch, George R.; Borenstein, Samuel R.; (and others). Phys. Rev., D; 4: No. 1, 53-5(1 Jul 1971).

A search was made for pairs of charged particles t^+t^- with spacelike four-momenta produced in K^-p interactions at 2.2 GeV/c. It was assumed that such particles could produce visible tracks in the bubble chamber. Under the additional assumption that only tachyons with velocities not much greater than the speed of light ($v \lesssim 1.7c$) could produce visible tracks, the experiment would be sensitive to tachyon invariant masses $\mu = (-p \cdot p)$ between 100 MeV and 1 GeV and to tachyon-pair invariant-mass-squared values between 0 and 1.44 GeV^2. No example of the reaction $K^-p \to \Lambda\, t^+t^-$ was found (for momentum transfer squared between 0 and -0.8 GeV^2), implying a cross section upper limit of ≈ 0.2 μb. (auth)

45679 RESONANCE PRODUCTION IN K^-–NEUTRON INTERACTIONS AT K^- MOMENTA OF 1.45 AND 1.65 GeV/c. Colley, D. C. (Univ. of Birmingham, Eng.); Cox. G. F.; Eastwood, D.; (and others). Nucl. Phys.; B31: No. 1, 61-85(1971).

Results are reported on K^--neutron interactions at c.m. energies near 2 GeV. The interactions are dominated by strong production of hyperon resonances, particularly $\Sigma(1385)$, $\Lambda(1405)$ and $\Lambda(1520)$. Production cross sections and angular distributions are given for the $\Sigma(1385)$, $\Lambda(1405)$ and $\Lambda(1520)$ and branching fractions to decay modes observed in the experiment are given for $\Sigma(1385)$ and $\Lambda(1520)$. The strong energy dependence of some features of the data suggests that s-channel effects are dominant. (auth)

45680 DIRECT EXPERIMENTAL ESTIMATE OF THE LOW ENERGY PARAMETERS FOR $\pi\Lambda$ SCATTERING. Cline, D.; Laumann, R.; Mapp, J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Lett.; 35B: No. 7, 606-9(19 Jul 1971).

The $\Lambda\pi^-$ angular distributions for the reaction $K^-d \to \Lambda\pi^-p$ for the $\Lambda\pi^-$ mass range from threshold to ~1400 MeV were analyzed using scattering length parameterizations. The $\Sigma(1385)$, P_{13} resonance amplitude is used as the reference amplitude. The $\pi\Lambda$ (S_{11}) scattering length and the $\pi\Lambda(P_{11})$ phase shift are found to be negative. The results appear to be inconsistent with the predictions of simple current algebra. (auth)

45681 DETERMINATION OF THE g-MESON SPIN. Grayer, G. (CERN, Geneva); Hyams, B.; Jones, C.; (and others). Phys. Lett.; 35B: No. 7, 610-11(19 Jul 1971).

A spherical harmonic moment analysis of 220,000 events of the reaction $\pi^-p \to \pi^-\pi^+n$ at 17.2 GeV/c determines the spin–parity of the g-meson to be 3^-. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 45795 and 45807.

45682 (COO-264-582) [THEORETICAL RESEARCH IN ELEMENTARY PARTICLE PHYSICS]. Supplement to Technical Progress Report, January–May 1971. (Chicago Univ., Ill. Enrico Fermi Inst.). Contract AT(11-1)-264. 6p. Dep. NTIS.

The summary of theoretical research in elementary particle physics includes dual hadrodynamics, high-energy scattering amplitudes, and processes involving leptons and weak bosons. (J.F.P.)

45683 (ITF-70-99) FUNDAMENTAL PROBLEMS OF THE ELEMENTARY PARTICLE THEORY. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 140p. Dep. NTIS (U. S. Sales Only).

The conference included eight papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 45720–45724, 45793, 45794, and 45807.

45684 (NYO-2262TA-239) DUAL RESONANCE MODELS FOR INCLUSIVE CROSS SECTIONS. Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 48p. (CONF-710519-1). Dep. NTIS.

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

Following previous work, through a generalized optical theorem, the single particle production cross section for the process $a + b \to x +$ anything is related to a forward discontinuity in a crossed-energy variable of the six-line amplitude $a + b + x' \to a' + b' + x$. Using the dual resonace models for the six-line amplitude an explicit form for the production cross section at high energies is obtained. The formula exhibits the expected features of limiting fragmentation, pionization, and triple-Regge behavior. In addition, it has a universal cut-off in transverse momentum of the form $e^{-4bP_\perp^2}$ in the pionization region, where b is the universal trajectory slope. Possible experimental relevance of the results is discussed. (auth)

45685 (ORO-3992-59) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report [No. 2]. Sudarshan, E. C. G.; Ne'eman, Yuval (Texas Univ., Austin. Center for Particle Theory). [nd]. Contract AT(40-1)-3992. 52p. Dep. NTIS.

The summary of theoretical research on elementary particles covers tachyons, the scattering of shadow states, field theory with an indefinite metric, algebraic and group theory methods, strong interaction phenomenology, scattering theory, weak interactions, related fields, and the history of particle physics. A list of abstracts for AEC reports is also included. (J.F.P.)

45686 FISICA DE PARTICULAS. (Particle Physics). Saavedra, Igor. Serie de Fisica. Monografia No. 4. Washington, D. C.; Pan American Union (1969). 106p. $0.75.

A summary on the field on particle physics is presented. Ideas and theories resulting from the special relativity theory and from quantum mechanics are outlined. Antimatter is discussed. The absolute conservation laws are considered. The atomic, the nuclear, and the strange particle families are described. The hazy distinction between particles and resonances is considered. The eightfold way and its prediction of quarks is discussed. (J.S.R.)

45687 TOTAL DIFFERENTIAL CROSS SECTIONS OF INELASTIC PROCESSES AT HIGH ENERGIES. Abramovskii, V. A.; Kancheli, O. V.; Mandzhavidze, I. D. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 5, 1102-15(May 1971). (In Russian).

The behavior of the total inelastic differential cross sections $\partial^3\sigma/\partial p^3$ at high energies and small momentum transfer of observable particles in quasi-two-particle and deep inelastic regions is considered under assumptions usual for the reggeon graph technique (r.g.t). The obtained r.g.t. for the values of $\partial^3\sigma/\partial p^3$ allows one to calculate the contribution not decreasing with energy (it appears to be factorized and longitudinally scale-invariant) and corrections decreasing with energy. Factorization leads to a number of relations between $\partial^3\sigma/\partial p^3$ for different types of particles. In the quasi-two-particle region the assumption on the duality of the reggeon-particle scattering amplitude makes it possible to obtain the ratio of the production differential cross sections (resonances)/(background). (auth)

45688 DATA REPRESENTATION AND MODIFIED DISPERSION RELATIONS. Ross, G. G. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B31: No. 1, 113-24(1971).

Following the Cutkosky theory of representation of data by analytic functions, a probability functional is introduced which takes account of the different statistical errors in the determination of the real and imaginary parts of a function along its boundary of analyticity. With this probability the most probable function is found and the mean value and standard deviation of any functional are determined in terms of this function. These results are applied to the problem of continuation of a function off its boundary and a modified dispersion relation derived which defines the best continuation possible given the form of the probability function. (auth)

45689 EFFECTS OF MASS SPLITTING ON THE SATURATION OF THE COLLINEARIZED ALGEBRA OF VECTOR CHARGE DENSITIES. Fahnline, Donald Edward. University Park, Pa.; Pennsylvania State Univ. (1970). 132p. University Microfilms Order No. 71-16,601.

Thesis.

The predictions of the collinearized Gell-Mann algebra of vector charge densities approximately saturated in the infinite momentum limit by finite sets of particles are obtained, and the effect of mass splitting on the predictions is studied. The $N-N^*$, the $\Xi-\Xi^*$, and the $\Sigma, \Lambda-Y^*$ saturations of the isovector algebra as well as the $\frac{1}{2}^+$ octet $-\frac{3}{2}^+$ decuplet saturation of the SU(3) vector algebra are considered. For each isovector saturation the matrix elements of the charge densities are expressed in terms of form factors using Lorentz invariance and conservation of the isovector current; then the infinite momentum limit is taken. The conditions of the Gell-Mann algebra are imposed on these matrix elements by means of the Barnes-Kazes solution of the algebra, yielding a set of conditions on the form factors. In general, there are more conditions than form factors, and they can be satisfied only by unphysical solutions for the form factors. However, if the conditions are expanded in powers of the momentum transfer, they can be satisfied in physically interesting ways to low orders. The predictions of the SU(3) saturation are obtained by using the SU(3) Wigner-Eckart theorem to relate the different isovector saturations. It is found that the mass degenerate solutions are consistent to the third order in the momentum transfer, while the mass nondegenerate solutions are consistent only to the second order. For the mass nondegenerate $N-N^*$ isovector saturation it is concluded that the $N-N^*$ electric quadrupole transition amplitude and the mass splitting effects make important contributions to the predictions. The mass degenerate SU(3) solution reproduces the SU(6) results and in addition predicts the proton and neutron charge radii. A mass nondegenerate solution to the SU(3) algebra exists, but its predictions are further away from experimental data than the mass degenerate predictions. (Diss. Abstr. Int., B)

Electromagnetic

Refer also to abstracts 45785 and 45814.

45690 (DESY-71/23) CONSIDERATIONS ON MEASURING $\gamma+\gamma\rightarrow\pi^+ + \pi^-$ WITH COLLIDING BEAMS. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1971. Contract AT(30-1)-4101. 13p. Dep. NTIS.

Differential cross sections for pionization in electron-electron (or electron-positron) colliding beams are largest when the produced pions have nearly equal but opposite transverse momenta. Measurement in this case can determine the two amplitudes and relative phase for $\gamma+\gamma\rightarrow\pi^+ + \pi^-$. (auth)

45691 (IFVE-SVM-70-63) ELECTRODYNAMICS OF CHARGED VECTOR MESONS WITH ANOMALOUS MAGNETIC MOMENT IN THE KEMMER FORMALISM. Kompaniets, V. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Electrodynamics of vector mesons with anomalous magnetic moment is described, and formalism analogous to the ξ-limiting formalism of Lee and Yang in the Kemmer representation was constructed. To transfer to the interaction representation, one makes use of the procedure suggested previously. The analysis of S-matrix is performed by the transfer from the t-ordered operator to the N-ordered operator of the S-matrix, on the whole. (auth)

45692 (JINR-E2-5778) ASYMPTOTICAL BEHAVIOR OF THE TOTAL γp- AND $\gamma\gamma$-CROSS SECTIONS OFF THE MASS SHELL. Efremov, A. V.; Ginzburg, I. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. (CONF-710609-4). Dep. NTIS (U. S. Sales Only).

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

It is shown that the Regge type behavior and the scaling law $S\sigma_{\gamma p} \approx f(S/q^2)$ give for $S\sigma_{\gamma\gamma}$ the asymptotics $\phi(SS_0/q_1^2q_2^2)$ at large S, q_1^2 and q_2^2. This result is confirmed by the summation of the diagrams in ϕ^3 theory. It is announced also that the introduction of the spin (γ^5 theory) results in a slight breaking of the scaling law and in the suppression of the scalar photon contribution to these processes compared with the contribution of the transversal photon. (auth)

45693 (LAL-RI-71-1) RADIATIVE EFFECTS IN THE SEMI-LEPTON DECAY OF K^+: $K^+ \rightarrow \pi^0 e^+ \nu$. Burban, Anne-Marie (Paris Univ., Orsay (France). Faculte des Sciences). Mar 1971. 123p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

After recalling theoretical and experimental results on the semi-lepton K^+ modes of decay the necessity of taking into account radiative corrections in the study of Ke3 is demonstrated. These corrections are calculated using numerous approximations and hypotheses. The matrix element is calculated and the characteristic distribution of the gamma radiation emitted as internal bremsstrahlung and the branching ratio $\Gamma(Ke3\gamma)/\Gamma(Ke3)$ deduced from it. All the radiative corrections to the Dalitz diagram of Ke3 are calculated, and from them, the corrections which must be applied to the Ke3 form factor are deduced. The theoretical calculations were verified experimentally. The rigorous selection of the experimental results made is described. Because of the small number of events remaining, only values for the branching ratio $\Gamma(Ke3\gamma)/\Gamma(Ke3)$ corresponding to different selected gamma energies are given. (France)

45694 (LNF-70/54) THEORETICAL REPORT ON PION PHOTOPRODUCTION BELOW 1 GeV. Schwela, D. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Dec 1970. 32p. (CONF-701121-7). Dep. NTIS (U. S. Sales Only).

From Meeting on electronsynchrotron; Frascati, Italy (5 Nov 1970).

A short survey of the present status of the theoretical description of the single pion photoproduction on nucleons below 1 GeV is given, and the results of a recent multipole analysis in the first resonance region are discussed. (J.F.P.)

45695 ELASTIC PHOTON-DEUTERON SCATTERING. Alimov, A. D.; Fil'kov, L. V. Kratk. Soobshch. Fiz.; No. 12, 29-36(Dec 1970). (In Russian).

Elastic scattering of photons on deuterons was studied within the limits of dispersion theory considering only the closest abnormal property t related to the triangle diagram. Calculations were made of the elastic γd scattering at 90, 110, and 140° angles in the energy range of the incoming γ quanta up to 430 MeV. (R.V.J.)

45696 CLASS OF ASYMPTOTIC LIMITS OF PION-ELECTROPRODUCTION OFF NUCLEONS. Mueller, V. F.; Ruehl, W. (Univ., Trier-Kaiserslautern, Ger.). Nucl. Phys.; B30: No. 2, 513-24(1971).

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Starting from a suitably chosen representation of the pion-electroproduction S-matrix element as a Fourier transform of a retarded causal distribution, a class of high-energy limits is investigated. (auth)

45697 ENERGY-INDEPENDENT MULTIPOLE ANALYSIS OF PION PHOTOPRODUCTION ON PROTONS BELOW 450 MeV. Berends, F. A. (Harvard Univ., Boston, Massachusetts Inst. of Tech., Cambridge); Weaver, D. L. Contracts AT(30-1)-2086; AT(30-1)-1984. Nucl. Phys.; B30: No. 2, 575-604(1971).

Results are presented of a multipole analysis of pion photoproduction on protons at 27 energies below a photon lab energy of 450 MeV, using almost all existing data. The analysis gives rise to one continuous solution. It is shown, however, that when omitting certain asymmetry ratio data, another solution is possible. The latter is closer to certain dispersion-theoretic predictions. A comparison of the solutions to the data and predictions for unmeasured quantities are given. In addition, the solutions are used to evaluate total cross sections for π^+ and π^0 photoproduction. As a by-product of certain fits, the πN coupling constant is evaluated from forward π^+ differential cross sections. A comparison of the solutions is made to two other multipole analyses. (auth)

45698 ANGULAR DISTRIBUTION OF SHOWER PARTICLES IN PLANE CONTAINING THE SHOWER AXIS. Guzhavin, V. V.; Potapova, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 13: No. 5, 1069-74(May 1971). (In Russian).

Angular distributions of particles in electron–photon showers are investigated as functions of the particle deviation angles projected upon a plane containing the shower axis. Analytical expressions for the functions are obtained in the approximation of small angles of the multiple scattering without account of the ionization loss. Dependence of the functions on the total energy of the shower, E_0, the angle projection, θ_x, and the cascade parameter, $\bar{s}$, is investigated. (auth)

45699 MULTIPOLE ANALYSIS OF REACTION $\gamma + N \rightarrow \pi + \Delta(1236)$. Zayats, A. A. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 5, 1075-86(May 1971). (In Russian).

Relations between different sets of amplitudes: invariant, chiral, and scalar, are obtained for the process $\gamma + N \rightarrow \pi + \Delta(1236)$. The expansion of the scalar amplitudes in the multipole amplitudes is obtained using the chiral amplitude technique. Formulas are given taking into account the contribution from transitions with the momentum and parity $J^\pi = 1/2^\pm, 3/2^\pm, 5/2^\pm$, for the differential cross section of the process $\gamma + N \rightarrow \pi + \Delta(1236)$ and the angular distribution asymmetry which is due to linearly polarized γ quanta. The contribution from two intermediate resonances with the spin and parity $3/2^-$ and $5/2^+$ is discussed in detail. (auth)

45700 ELECTROMAGNETIC FORM FACTORS WITH INFINITE NUMBER OF ZEROS. Geshkenbein, B. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 5, 1087-90(May 1971). (In Russian).

The π-meson electromagnetic form factor with infinite number of zeroes in the complex $z = q^2/4m_\pi^2$ plane is considered. It is shown that even for this form factor all limitations on its behavior in the space-like region obtained previously are valid, where besides usual analytical properties of the form factor, an additional assumption was used that the form factor has finite number of zeroes in the complex z plane. (auth)

45701 ANOMALOUS MAGNETIC MOMENT OF NUCLEON. Goloskokov, S. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1091-5(May 1971). (In Russian).

The anomalous magnetic moment is calculated on the basis of the Bincer dispersion relations. The dependence of the anomalous magnetic moment on the nuclear moment of nucleon related to the ρNN interaction is obtained. (auth)

45702 PROPOSED TEST OF CHARGE-CONJUGATION INVARIANCE IN POSITRONIUM DECAY. Mani, H. S.; Rich, Arthur (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 4: No. 1, 122-7(1 Jul 1971).

If the electromagnetic interactions are invariant under charge conjugation, C, then singlet positronium (Ps) can only decay into an even number of photons, while triplet Ps can only decay into an odd number of photons. A model Hamiltonian is considered which violates C invariance but conserves parity. If λ is the coupling constant in the proposed C-noninvariant interaction, then the branching ratio of the forbidden decay, $1\,^3S_1 \rightarrow 4\gamma$, to the allowed decay, $1\,^3S_1 \rightarrow 3\gamma$, has been found to be $F_1^Q = 1.2 \times 10^{-5}\lambda^2$. An experimental upper limit on $F_1^{4\gamma}$ would provide a novel check of C invariance in electromagnetic interactions, and would also yield new information on the $\bar{e}e\,\gamma\gamma\gamma\gamma$ interaction. At present, indirect limits on F_1^4 show it to be less than about 10^{-2}. An experiment is designed to reduce this upper limit to $10^{-5} - 10^{-6}$. If successful, it will subject the proposed interaction, or any similar interaction leading to $1\,^3S_1 \rightarrow 4\gamma$, to a stringent test. An outline of the experiment is included in this paper. (auth)

45703 THEORY OF $\eta-\pi$ MIXING WITH APPLICATIONS TO MESON DECAYS. Brown, Laurie M. (Northwestern Univ., Evanston, Ill.); Deshpande, Nilendra G.; Costanzi, Frank A. Phys. Rev., D; 4: No. 1, 145-50(1 Jul 1971).

From a consideration of the intrinsic and radiative contributions to $\eta-\pi$ mixing, calculated in an effective-chiral-Lagrangian model, a satisfactory account is given of the process $\eta \rightarrow 3\pi$. The model lends itself to further application to the G-violating decay $\rho^\pm \rightarrow \eta\pi^\pm$, as well as to the weak processes $K^\pm \rightarrow \pi^\pm + \pi^0$ and $K^\pm \rightarrow \pi^\pm + \gamma + \gamma$. Also predicted are rates for $\varphi \rightarrow \eta + \gamma$ and $\omega \rightarrow \eta + \gamma$. (auth)

45704 ANOMALOUS REAL PARTS IN ω PHOTOPRODUCTION. Greenhut, Gary K. (Seton Hall Univ., South Orange, N. J.). Phys. Rev., D; 4: No. 1, 253-5(1 Jul 1971).

The anomalous real parts in ω photoproduction and elastic scattering from nucleons are calculated. The effect of anomalous real parts on the maximum $\rho-\omega$ phase allowed by nuclear absorption in photoproduction from complex nuclei is discussed. A large time-reversal-invariance-violating phase is needed at the vector-meson-photon vertex in order to correlate the $\rho-\omega$ phase measurements in photoproduction of lepton and pion pairs and in pion-pair production in colliding beams. (auth)

45705 MULTIPOLE ANALYSIS OF π^- PHOTOPRODUCTION IN THE ENERGY REGION BETWEEN 180 MeV AND 420 MeV. Noelle, P.; Pfeil, W. (Univ., Bonn). Nucl. Phys.; B31: No. 1, 1-14(1971).

An energy-dependent phenomenological multipole analysis of π^- photoproduction for photon lab energies between 180 MeV and 420 MeV was carried out. The isoscalar parts of the $l \leq 1$ multipoles were parametrized by polynomials of the c.m.s. energy W. The $l \geq 2$ multipoles were included in Born approximation. The imaginary parts of the multipoles were calculated from the real parts by use of the Watson theorem. A consistent representation of the available experimental data was obtained. The energy dependence of the electric dipole $E_{0+}^{(0)}$ appears to be stronger than predicted by theory. Only small deviations from the Born approximations occur from the amplitudes $E_{1+}^{(0)}$, $M_{1+}^{(0)}$ and $M_{1-}^{(0)}$. Evidence for an isotensor part in the electromagnetic current is not established. (auth)

45706 INELASTIC LEPTON SCATTERING FROM NUCLEONS AND POSITIVITY RESTRICTIONS. Doncel, M. G. (Univ. of Barcelona); De Rafael, E. Nuovo Cim.; 4A: No. 2, 363-82(21 Jul 1971).

The complete sets of restrictions among structure functions which stem from the semi-positive definiteness of the electromagnetic and weak hadronic tensors are derived. Applications are made to inelastic scattering of electrons or muons from polarized nucleons, inelastic scattering of polarized electrons or muons from polarized nucleons and inelastic scattering of neutrinos from nucleons with subsequent analysis of the polarization of the outgoing muon. (auth)

Weak

Refer also to abstracts 45784 and 46108.

45707 (OU-LNS-71-3) LEPTON-BARYON RESONANCES AND DUALITY IN WEAK PROCESSES. Nakawaki, Yuji; Saito, Takesi; Sakai, Yosiki; Tanikawa, Yasutaka (Osaka Univ. (Japan). Lab. of Nuclear Studies). Mar 1971. 8p. Dep. NTIS (U. S. Sales Only).

The existence of a μ^+n resonance (a u-channel resonance lying on a Regge trajectory) is assumed as well as the previous μ^-p resonance and is introduced into the previous Veneziano model for the process $\nu + n \rightarrow \mu^- + p$. It is shown that a new model reduced the energy dependence of quantities corresponding to the vector and axial-vector form factors to be much smaller than that in the previous model. (J.F.P.)

45708 ELECTROMAGNETIC FINAL-STATE INTERACTIONS IN THE LEPTONIC DECAYS OF THE NEUTRAL KAON. I. K_{l3} MODE. Brodine, John C. (Carnegie–Mellon Univ., Pittsburgh). Nucl. Phys.; B30: No. 2, 545-74(1971).

A calculation of the Coulomb final-state interaction effects in the decays $K_L \rightarrow \pi^\pm l^\pm \nu_l$ is presented. Specifically the charge asymmetry and the transverse polarization of the charged lepton are investigated. The effects of possible $\Delta Q = -\Delta S$ amplitudes and the q^2 dependence of the form factors are considered. The variation of the effects over the Dalitz plot is discussed and many numerical results are given. (auth)

45709 IS UNITARITY A MUST FOR THE EXISTENCE OF THE SUM RULES FOR K_L–K_S DECAY. Gien, T. T. (Memorial Univ. of Newfoundland, St. John's). Can. J. Phys.; 49: 1644-8(15 Jun 1971).

The sum rules for $K_L - K_S$ decay still can be derived even if the S matrix is only asked to satisfy a weaker condition than unitarity. Consequently, such sum rules still exist for a physical process with an absorption effect present. (auth) (Canada)

45710 K_{l3} DECAY, ELASTIC UNITARITY, AND THE SYMMETRY-BREAKING PARAMETER OF THE VACUUM STATES. Chan, Francis C. P. (Saginaw Valley Coll., University Center, Mich.). Phys. Rev., D; 4: No. 1, 189-94(1 Jul 1971).

K_{l3} form factors are derived in the hard-pion approach without using vector- or axial-vector-meson dominance and with more general consideration of symmetry breaking. Elastic unitarity is employed for the vector form factor. The ratio $f_-(0)/f_+(0)$ is expressed in terms of the symmetry-breaking parameter, $b = \langle 0|u_8|0\rangle/\langle 0|u_0|0\rangle$. It is found that current algebra can provide a satisfactory explanation for the decay parameters. (auth)

45711 CP NONCONSERVATION AND INEQUALITIES BETWEEN $\mu^+\mu^-$ AND 2γ DECAY RATES OF K_S^0 AND K_L^0. Christ, N.; Lee, T. D. (Columbia Univ., New York). Phys. Rev., D; 4: No. 1, 209-12(1 Jul 1971).

Assuming that the absorptive part of $K_L^0 \to 2\mu$ is due only to the on-mass-shell 2γ intermediate states, several inequalities between 2μ and 2γ decay states of K_S^0 and K_L^0 are derived without the assumption of CP conservation. These inequalities, together with the present experimental upper bound on $K_L^0 \to 2\mu$, imply that the branching ratio for $K_S^0 \to 2\mu$ should be greater than 5×10^{-7}. (auth)

45712 WEAK RADIATIVE DECAY OF THE Σ^+ AND Λ HYPERONS. Farrar, Glennys R. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 1, 212-20(1 Jul 1971).

Unitarity is found to give a reliable, model-independent lower bound on the branching ratio $[\text{rate}(\Lambda \to n\gamma)/\text{rate}(\Lambda \to \text{all})] > 8.5 \times 10^{-4}$. This value is nearly as large as the experimentally determined branching ratio for the decay $\Sigma^+ \to p\gamma$. Dispersion-theoretic techniques supplemented with current algebra, PCAC, and pole models are then used to determine the real as well as imaginary parts of the amplitudes for the radiative decays of Λ and Σ^+ hyperons. Input consists of the experimental nonleptonic decay amplitudes and pion–nucleon phase shifts. The theoretical predictions are very sensitive to the hyperon magnetic moments, and until these are better known, these results for the radiative decays can only be qualitatively compared with experiment. (auth)

45713 COMMENTS ON A RIGOROUS BOUND FOR THE $f_+(0)$ FORM FACTOR OF K_{l3} DECAY. Li, Ling-fong; Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev., D; 4: No. 1, 255-6(1 Jul 1971).

A rigorous bound on the form factor $f_+(0)$ in the form $|f_+(0)| \leq [16/(m_K - m_\pi) \times (\sqrt{m_K} + \sqrt{m_\pi})][\pi\Delta(0)/3(m_K + m_\pi)]^{\frac{1}{2}}$, where $\Delta(0)$ is the propagator of the divergence of the strangeness-changing current at zero momentum transfer. Using the estimate of Mathur and Okubo for $\Delta(0)$, $|f_+(0)| \leq 1.0$ and $|f_K/f_\pi| \leq 1.28$ are obtained. (auth)

45714 RENORMALIZATION OF MASS AND WAVE FUNCTION IN THE LOWEST ORDER OF THE PERTURBATION THEORY IN THE MODEL OF WEAK INTERACTION WITH INTERMEDIATE VECTOR BOSON. Kitanin, A. L.; Yakubov, A. F. Vestn. Leningrad. Univ., No. 22, Fiz. Khim.; No. 4, 7-13(Nov 1970). (In Russian).

The renormalized mass operator, renormalization matrix, and bare mass matrix are calculated in the lowest order of the perturbation theory for weak interactions of leptons and weak interactions of quarks in theory with intermediate vector boson. (auth)

45715 RADIATIVE CORRECTIONS TO K_{l3} DALITZ PLOT. Kamal, A. N.; Wong, N. N. (Univ. of Alberta, Edmonton). Nucl. Phys.; B31: No. 1, 48-60(1971).

The radiative corrections to the Dalitz plot of $K_{e3}^\pm$ and $K_{\mu3}^\pm$ were calculated in conventional quantum electrodynamics to order e^2. The results reported are applicable to that part of the Dalitz plot where the lepton (e or μ) and pion energies are near their maxima. The precise region of applicability of the results is defined in the text. It is found that the radiative corrections to K_{e3} Dalitz plot are large and negative in this region (of the order of -1% to -10%). The corrections to $K_{\mu3}$ Dalitz plot are small, being less than 1% in magnitude. (auth)

45716 ANALYTIC RENORMALISATION OF THE EXPONENTIAL INTERACTION AND WEAK INTERACTION SINGULARITIES. Mitter, P. K. (Oxford Univ.). Commun. Math. Phys.; 20: No. 4, 251-67(1971).

The parity nonconserving interaction of a neutral vector meson with fermions is considered as a mathematical model suitable for investigating divergence problems of the weak interactions. Through the Stuckelberg formalism and a canonical transformation the interaction is converted into an exponential form. The exponential interaction is studied, in the second order of perturbation theory, through the method of analytic renormalisation. Generalised amplitudes are introduced as localizable distributions depending on auxiliary complex parameters λ. It is shown that the distributions possess a nonisolated singularity at the physical point λ_0. A method is developed for discarding the singularity thereby obtaining the physical amplitudes as localizable distributions which display a non-analytic dependence on the coupling constant. (auth)

45717 DISPERSION APPROACH TO THE INVESTIGATION OF THE WEAK NUCLEON–NUCLEON INTERACTION. Danilov, G. S. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 35B: No. 7, 579-80(19 Jul 1971).

A dispersion method for calculation of the parity violating NN amplitude is suggested. Under some usual assumptions about the values of the meson-nucleon coupling constant the circular polarization γ-quanta P and its asymmetry α (with respect to neutron spin) in the process $n + p \to d + \gamma$ is obtained: $P = 1.81 \times 10^{-8}$, $\alpha = 4 \times 10^{-9}$. (auth)

45718 SOFT PION SOLUTION OF K_{l3} PARAMETERS. Mathur, V. S.; Yang, T. C. (Univ. of Rochester, N. Y.). Phys. Lett.; 35B: No. 7, 599-603(19 Jul 1971).

A new soft-pion relation involving the K_{l3} form-factors is proposed. Together with the well-known soft pion theorem, a solution of the K_{l3} parameters is obtained under various assumptions of linearity of form-factors. (auth)

Strong (General)

Refer also to abstract 45793.

45719 (CERN-Trans–71-14) VECTOR DOMINANCE AND THE REDUCTION OF THE DIFFERENTIAL CROSS-SECTION OF LEPTON PAIR PRODUCTION AT HIGH ENERGIES AT LARGE ANGLES. Mestvirishvili, M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Sanders (CERN, Geneva, Switzerland), from report IFVE-STF-70-46. 5p. Dep. NTIS (U. S. Sales Only).

It is shown on the basis of the vector dominance hypothesis that the differential cross sections for lepton pair production in the region of large angles decreases as the energy increases. The process when the lepton pair is produced by a collision of two hadrons is considered. (J.F.P.)

45720 (ITF–70-99, pp 59-96) IMPACT PICTURE: THEORY OF HIGH-ENERGY SCATTERING. Wu, T. T. (Harvard Univ., Cambridge, Mass.); Cheng, H. (Massachusetts Inst. of Tech., Cambridge).

In Fundamental problems of the elementary particle theory.

The impact theory of high-energy scattering is considered for hadron collisions. Predictions are discussed for the total and differential cross sections, the diffraction widths, and the real and imaginary parts of the scattering amplitudes for these processes. The lowest-order calculation, impact-factor representation, pionization, and limiting behavior of the cross sections are covered. (J.F.P.)

45721 (ITF–70-99, pp 97-101) SCATTERING AT HIGH ENERGIES AS A STOCHASTIC PROCESS. Logunov, A. A.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii).

In Fundamental problems of the elementary particle theory.

An approach similar to the eikonal and the statistical model of scattering is used for the properties of strong interactions at high energies. In this approach, scattering can be described in terms of a new stochastic variable which is the number of particles which can transfer the given momentum. (J.F.P.)

45722 (ITF–70-99, pp 102-12) COHERENT STATE MODEL OF HIGH-ENERGY HADRON COLLISIONS. Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR)).

In Fundamental problems of the elementary particle theory.

Two-hadron scattering in the coherent-state model is considered. The scattering is treated as an interaction of two oscillator-type systems, each of which is described by the coherent state vector.

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It is assumed that the interaction of such systems is due to the absorption and production of oscillator excitations or quants. (J.F.P.)

45723 (ITF-70-99, pp 113-30) DYNAMICAL MODEL OF DUAL RESONANCE AMPLITUDES. Sakita, B. (Wisconsin Univ., Madison).

In Fundamental problems of the elementary particle theory.

One aspect of the dual resonance model is given based on previous work. The Feynman diagrams are considered for strong interaction amplitudes. (J.F.P.)

45724 (ITF-70-99, pp 131-9) HIGH ENERGY HADRON-HADRON COLLISIONS. Yang, C. H. (New York Univ., N. Y.).

In Fundamental problems of the elementary particle theory.

This brief review of hadron-hadron collisions covers the general features of high-energy collisions, the physical pictures of elastic high-energy collisions and of inelastic processes at very high energies, and some speculative considerations concerning the geometrical size of hadrons. (J.F.P.)

45725 (JINR-E2-5850) OSCILLATORY LEVELS OF A PARTICLE AS A RESULT OF STRONG INTERACTION WITH THE FIELD. Solodovnikova, E. P.; Tavkhelidze, A. N.; Khrustalev, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 35p. Dep. NTIS (U. S. Sales Only).

The motion of a particle which interacts strongly with the scalar field, is separated by using the Bogolubov transformation. The effective potential for the particle in this case reduces to the oscillator potential. (auth)

45726 VVEDENIE V TEORIYU SIL'NO-VZAIMODEISTVUYUSHCHIKH ELEMENTARNYKH CHASTITS. (Introduction into the Theory of Strongly Interacting Particles). Nelipa, N. F. Moscow; Atomizdat (1970). 488p.

The invariant properties of physical systems and the invariant structure of the amplitude process are considered. Transformation of particle wave functions, scalar particles, particles with various spins, differential cross sections for processes with three and four particles were studied considering processes with and without baryons, isotopic invariability, cross symmetry, unitarian hadron multiplets, SU_3 and SU_6 symmetry, and π meson scattering on protons and scattering of nucleons on nucleons. The methods of one-dimensional and binary dispersion relations, complex moments, dispersional sum rules and algebra of currents are covered. The elementary particle tables, Klebsh-Gordan coefficients, spherical functions, and space symmetry groups are also included. 89 references. (R.V.J.)

45727 INTERFERENCE OF IDENTICAL PARTICLES IN PROCESSES WITH EXCITED NUCLEI AND RESONANCE STATES. Grishin, V. G.; Kopylov, G. I.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1116-25(May 1971). (In Russian).

Interference of identical particles in processes with excited nuclei or resonance states is considered. A possibility of measuring the resonance widths on this basis is discussed. (auth)

45728 REVIEW OF RECENT WORK ON NARROW RESONANCE MODELS. Sivers, Dennis (Univ. of California, Berkeley); Yellin, Joel. Rev. Mod. Phys.; 43: No. 2, 125-88(Apr 1971).

Recent work on narrow resonance models is reviewed. The point of view is taken that such models play a role similar to that of the Lee model in quantum field theory, and that they cannot therefore be directly compared with experiment. Examples of various aspects of these models, including general self-consistency and the construction of amplitudes with external currents are reviewed, and the related diseases are listed. A critical discussion of narrow resonance phenomenology is given. Associated questions which seem suitable for further study are discussed and summarized. (auth)

45729 DETERMINATION OF THE SLOPES OF DIFFRACTION PEAKS FOR HADRONIC PROCESSES. Chiu, Charles B. (California Inst. of Tech., Pasadena); Hwa, Rudolph C. Phys. Rev., D; 4: No. 1, 224-8(1 Jul 1971).

A dispersion formula for the Pomeranchukon form factor is derived in the bootstrap model. In this model the Pomeranchukon is a fixed branch point at $j = 1$. Furthermore, the discontinuity of the branch cut vanishes at the tip of the cut. Thus, in the neighborhood of $j = 1$, the Pomeranchukon is weak. This property makes possible the linearization of the t-channel unitarity equation, which relates the Pomeranchukon form factor with the non-Pomeranchukon background. Assuming only f(1260) and f'(1514) contributions to the $I = 0$, even-signature, non-Pomeranchukon background, the slopes of the diffraction peaks are calculated for high-energy processes involving N, π, K, ρ, ω, and ϕ. No parameters are used. The results agree well with experimental data. (auth)

45730 MULTIPLICITY DISTRIBUTIONS IN REGGE-POLE-DOMINATED INCLUSIVE REACTIONS. Mueller, A. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 1, 150-5(1 Jul 1971).

Multiplicity distributions, the dependence on n of $\psi_n = \sigma_n/\sigma$, are discussed. Within the framework of the Amati-Fubini-Stanghellini model, a cluster expansion for the moments of ψ_n is derived. This same expansion is then derived as a consequence of asymptotic dominance of inclusive reactions by an isolated, factorizable Regge pole. Such an expansion furnishes a systematic way of describing the shape of ψ_n. It is argued that a Poisson distribution for multiple particle production can not be expected to occur, even for very high energies. (auth)

45731 SPIN AND SU(3) IN A GHOST-FREE DUAL MODEL. Bars, Itzhak (Yale Univ., New Haven). Nucl. Phys.; B31: No. 1, 15-28(1971).

Two problems are treated under the assumption that the amplitude is given as a sum of permutations of terms related to definite orderings of the external particles. Firstly, it is shown that isospin invariance, absence of exotic states, duality and factorization force a decomposition of each permutation into a SU(3) factor times an SU(3) invariant function. The SU(3) factor is uniquely determined as $\frac{1}{2}\mathrm{Tr}\,(\lambda^{\alpha_1}\lambda^{\alpha_2}\ldots\lambda^{\alpha_n})$. Secondly, if spin is introduced as proposed by Mandelstam, Bardakçi and Halpern, it is suggested that a modification of their spin factors transforms the ghost intermediate states into real particles. Thus, a dual model with SU(3) and spin is developed whose only ghosts come from the Beta function at daughter levels. Tachyons cannot appear in this model. (auth)

45732 DEGENERACY BREAKING IN A GHOST-FREE DUAL MODEL WITH SPIN AND SU(3). Bars, Itzhak (Yale Univ., New Haven). Nucl. Phys.; B31: No. 1, 29-47(1971).

A systematic program for degeneracy breaking is proposed for a dual model in which SU(3) and spin are treated through traces of SU(12) matrices. The program is carried out in detail for the four-point function and then formulated in terms of simple diagrammatic rules for the n-point function. (auth)

45733 GENERALIZED VENEZIANO MODEL WITH SPIN AND ISOSPIN FOR $\bar{N}NK\bar{K}\pi$ PROCESSES. Benfatto, G. (Univ., Rome); Lusignoli, M.; Nicolo, F. Nuovo Cim.; 4A: No. 2, 209-28(21 Jul 1971).

A Veneziano-type model is proposed for the $N\bar{N}K\bar{K}\pi$ processes having the correct asymptotic behavior and spin structure, the right isospin and signature on the parent trajectories and the appropriate factorization properties on the lowest poles. The requirement of a minimum number of satellite terms greatly reduces the number of free parameters. (auth)

45734 V-A INTERACTION IN A SEMI-RELATIVISTIC QUARK MODEL. Schilcher, K. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Beirut); Mueller, H. J. W. Nuovo Cim.; 4A: No. 2, 243-50(21 Jul 1971).

The two-particle Dirac equation and a V-A interaction are used as a semi-relativistic description of the quark-antiquark bound-state problem. With the help of specific examples—the square-well and the Gaussian potentials—the binding strength is investigated. Choosing reasonable values for the coupling strength and for the range of the Gaussian potential a mass of the pion of the right order of magnitude was found. (auth)

45735 INCLUSIVE REACTIONS AND THE ADDITIVE QUARK MODEL. Bialas, A. (Jagellonian Univ., Krakow); Czyzewski, O. Phys. Lett.; 35B: No. 7, 576-8(19 Jul 1971).

Sum rules for meson and antibaryon production in inclusive reactions are derived in the framework of the additive quark model. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 45817.

45736 (COO-1764-118) THEORETICAL REMARKS ON THE A_2 MESON. Rosner, Jonathan L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). [1971]. Contract AT(11-1)-1764. 34p. Dep. NTIS.

The A_2 is in no way anomalous regarding its SU(3) properties or production mechanism. Evidence regarding substructure (or lack thereof) in the peak is discussed with particular regard to any further experiments that may be planned. (auth)

45737 ELIMINATION OF PARITY DOUBLED STATES FROM REGGE AMPLITUDES. Carlitz, Robert David. Pasadena, Calif.; California Inst. of Tech. (1971). 51p. University Microfilms Order No. 71-16,211.

Thesis.

The common belief that fermions lying on linear Regge trajectories must have opposite-parity partners is shown to be false. The mechanism by which these experimentally nonexistent states are eliminated from the theory depends on the presence of fixed Regge cuts in fermion exchange amplitudes. Thus it is predicted that fermion Regge trajectories are always accompanied by fixed Regge cuts. More generally, if particles may be classified as composites of spin-$\frac{1}{2}$ (fermion) quarks, fixed cuts are expected to be present in boson exchange amplitudes as well. This result is demonstrated in the framework of the Van Hove model and a few further experimental consequences are discussed. (Diss. Abstr. Int., B)

45738 ROLE OF REGGE POLES AND CUTS IN HIGH-ENERGY PHENOMENOLOGY. Chiu, Charles B. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Nucl. Phys.; B30: No. 2, 477-512(1971).

The successes and the failures of the Regge-pole model in explaining the high-energy data are surveyed. It is stressed that at present energies the Regge-pole model works reasonably well, at least up to $t = -1.0$ GeV^2 for those reactions characterized by the dominance of the t-channel helicity-flip amplitude. But the same model fails to describe features of the t-channel helicity-non-flip and the double-flip amplitudes. For the non-flip amplitudes studied, in addition to the leading Regge pole, the extra contribution needed, which is suggested to be the cut, has to have a comparable strength to that of the pole at around $t = -0.2$ GeV^2 and it dominates over the pole in the larger negative t-region. For the double-flip amplitudes, the cut contribution is needed to totally mask the nonsense wrong-signature zero of the pole. The qualitative feature of the described relative importance of poles and cuts in the various helicity amplitudes is present in several cut models, such as the absorption model and the Carlitz–Kislinger model. As far as the present phenomenological models, such as the Regge-pole model, the weak-cut and the strong-cut models, are concerned one can claim, from our point of view, at best only a partial success in describing the data. At this stage, a phenomenological model which explicitly takes into account the prescribed role of poles and cuts is lacking. (auth)

45739 MODEL FOR VECTOR–VECTOR–TENSOR MESON COUPLING CONSTANTS. Renner, B. (Univ., Hamburg). Nucl. Phys.; B30: No. 2, 634-40(1971).

By the joint assumptions of vector-meson dominance for the electromagnetic current and tensor-meson dominance for the energy-momentum tensor a model for the vector-vector-tensor meson vertex is developed, including also the coupling of two photons to a tensor meson and the coupling of one photon to the vector-tensor meson system. In its simplest possible form the model has no undetermined parameters. Tentatively the vertex is applied to compute a tensor-meson exchange contribution to vector-meson scattering from an unpolarized target, and s-channel helicity conservation is found at large energies. (auth)

45740 DECAY PATTERN OF HIGH-SPIN RESONANCES IN THE GENERALIZED VENEZIANO MODEL. Hong-Mo, Chan; Tsun, Tsou Sheung (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 1, 156-72(1 Jul 1971).

The generalized Veneziano model in its factorized form allows in principle the calculation of all widths of resonances in terms of two parameters, namely (i) the coupling constant g determining the over-all normalization, and (ii) the intercept α_0 related to the meson mass m ($\alpha_0 = -m^2$). By explicitly evaluating and summing partial widths of resonances on the parent and some high-lying daughter trajectories, it is demonstrated that heavy narrow resonances exist in the model. The total widths of these resonances are found to decrease slowly as one moves to higher masses along a trajectory. For example, if one normalizes the width of the spin-1 particle on the parent trajectory to 100 MeV (ρ meson), the total width at spin-9 (mass ~3 GeV) is found to be 24 MeV, which corresponds well to missing-mass spectrometer results. A detailed study of the decay patterns of these resonances shows that the main mode of decay is one of cascade, where the resonance loses a few units of angular momentum and emits a meson at every step. To help experimenters plan future experiments, the numerical values for the widths of all important decay modes are presented. In addition, the investigation suggests that narrow high-spin resonances have a low formation cross section and are best produced in reactions with several particles in the final state. (auth)

45741 S-WAVE $\pi-\pi$ SCATTERING PHASE SHIFTS. Kim, H.; Bander, Myron (Univ. of California, Irvine). Phys. Rev., D; 4: No. 1, 265-7(1 Jul 1971).

Using an absorptive one-pion exchange mechanism for the reaction $\pi^-p \rightarrow \pi^+\pi^-n$, a fit is made to experimental data at 4 GeV/c in order to extract the $\pi-\pi$ scattering phase shifts. The analysis was carried out up to D waves in the $\pi-\pi$ amplitude. The best results indicate a very broad I = 0 S-wave resonance with $M_R = 820$ MeV and $\Gamma = 600$ MeV. (auth)

45742 APPLICATION OF THE VENEZIANO MODEL TO $p\bar{p} \rightarrow \pi^+\pi^-\omega^0$ DECAY AT REST. Hussain, F.; Rahman, I.; Razmi, M. S. K. (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 4: No. 1, 176-80(1 Jul 1971).

The decay $p\bar{p} \rightarrow \pi^+\pi^-\omega^0$ at rest is described in terms of the Veneziano model for four-point functions. The initial state carries the quantum numbers of a pion and an ω meson, so that the Veneziano model is used for $\pi\pi \rightarrow \pi\omega$ and $\pi\omega \rightarrow \pi\omega$. A fit with the data is attempted and reasonable agreement with experiment obtained. (auth)

45743 $\pi^0-\eta^0-X^0$ MIXING IN BROKEN CHIRAL SYMMETRY. Dutt, Ranabir; Eliezer, Shalom (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 4: No. 1, 180-9(1 Jul 1971).

The mixing of π^0, η, and X(958) mesons was investigated within the framework of the broken-chiral-symmetry model of Gell–Mann, Oakes, and Renner. Considering SU(2) symmetry breaking of the Hamiltonian due to the nonelectromagnetic isospin-violation term (so-called u_3) and imposing the smoothness assumption on certain three-point vertex functions, the mixing angles and the symmetry-breaking parameters are calculated in terms of the known masses of the pseudoscalar mesons and one input variable, $F = f_K/f_\pi$. Two sets of solutions (e.g., $\eta-X$ mixing angle $\omega \approx 10.5°$ or 19° for F = 1) are obtained and negligible mixing between π^0-X compared to $\pi^0-\eta$ is predicted. The effect of the vacuum symmetry breaking on these mixing parameters was studied as well. In the case of an SU(3)-invariant vacuum, the known results about $\eta-X$ and $\pi^0-\eta$ mixings are reproduced separately the corrections to the Gell–Mann–Okubo mass formulas are obtained. (auth)

45744 CORRELATIONS BETWEEN A_1 AND B DECAYS IN CHIRAL SL(8,C). Murtaza, G.; Harun-ar Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 4: No. 1, 221-3(1 Jul 1971).

A correlation between the helicity amplitudes for the $A_1 \rightarrow \rho + \pi$ and $B \rightarrow \omega + \pi$ decays is obtained with the help of an effective Lagrangian, invariant under chiral SL(8,C). Recently available experimental data agree with the relation obtained. (auth)

45745 FACTORIZABLE DUAL MODEL OF PIONS. Neveu, A.; Schwarz, J. H. (Princeton Univ., N. J.). Contract AT(30-1)-4159. Nucl. Phys.; B31: No. 1, 86-112(1971).

A new dual-resonance model of mesons is constructed through the use of creation and annihilation operators having simple anticommutation properties as well as harmonic-oscillator type operators of the conventional model. This model has the following virtues not shared by the conventional one: (i) The leading trajectory ($\rho-f^0$) does not make a particle when it passes through zero. (ii) A π-trajectory lies one-half unit below the ρ-trajectory. (iii) Trajectories with abnormal-parity couplings to pions, such as $\omega-A_2$ and η', also occur. (iv) The π, ρ, f^0, ω, A_2 and η' are all forced to have the proper G-parity and isospin. (v) The amplitudes for $\pi\pi \rightarrow \pi\pi$ and $\pi\pi \rightarrow \pi\omega$ are precisely the ones that have been suggested previously. (vi) The model contains neither embarrassing unobserved low-mass states nor an excessive number of high-mass states. (vii) All the physical states that we have checked have positive norms. Some shortcomings of the model are also listed: (a) Trajectories with normal-parity couplings occur one-half unit too high. Thus, for example, $\alpha_\rho(0) = 1$ and $\alpha_\pi(0) = \frac{1}{2}$, so that the π is a tachyon and the ρ is massless. On the other hand, the abnormal-parity trajectories are nicely located. For example, $\alpha_\omega(0) = \frac{1}{2}$ and $\alpha_{\eta'}(0) = -1$. (b) A straightforward generalization to SU(3) is unsatisfactory because of the non-degeneracy of the ρ and ω. These features of the model clearly indicate that it is not accurately describing the read world. Perhaps its most important property is that it contains a gauge algebra larger than the Virasoro algebra of the conventional model. It is believed that an understanding of this algebra may prove to be very important in the construction of more realistic models. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 45668, 45669, and 45810.

45746 (INP–755) PION PRODUCTION MECHANISM IN HIGH MULTIPLICITY π^+p INTERACTIONS AT 8 GeV/c. Coghen, T.; Czyzewski, O.; Eskreys, A.; Loskiewicz, K.; Malecki, P.; Zaorska, J.; Eskreys, K.; Juszczak-Dziunikowska, K.; Kisielewska, D.;

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Zielinski, W. (Institute of Nuclear Physics, Krakow (Poland)). 1971. 30p. Dep. NTIS (U. S. Sales Only).

The mechanism of pion production in eight-prong π^+p reactions is discussed in terms of two models: the "fireball" model and the multiperipheral CZA model. Both models give adequate description of the general features of the experimental data but they fail in prediction of the fine details of the processes. (auth)

45747 (INR-P-1323) FORM FACTORS AND DECAY DISTRIBUTIONS OF RESONANCES IN THE ONE-PION EXCHANGE MODEL APPLIED TO THE REACTION $\pi^+p \rightarrow \rho^0\Delta^{++}$. Gokieli, R. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 20p. Dep. NTIS (U. S. Sales Only).

The one-pion exchange model with the old off-shell extrapolation method is shown to reproduce the shape of the experimental differential cross section (de/dt) of the reaction $\pi^+p \rightarrow \rho^0\Delta^{++}$. In this version of the one-pion exchange model the shape of the (de/dt) is determined only by the pion propagator squared. The additional form factors proposed previously are shown to correct mainly the total cross section. The calculated theoretical distributions of decay angles are in fair agreement with experimental data, although the present form of the model cannot reproduce the observed angular correlations which relate the decays of ρ^0 and Δ^{++}. (auth)

45748 CLASSICAL SPIN VARIABLES AND CLASSICAL COUNTERPART OF THE DIRAC–FEYNMAN–GELL-MANN EQUATION. Depaquit, S.; Gueret, Ph.; Vigier, J. P. (Institut Henri Poincare, Paris). Int. J. Theor. Phys.; 4: 19-32(1971).

In an extended relativistic fluid droplet, it is possible to define new internal variables which correspond to the classical counterpart of spin. If a new constraint is introduced different from Weysenhoff's, the Feynman–Gell-Mann wave equation is obtained by quantization. This also yields a theoretical connection between mass and spin which can be compared with the observed baryon boson mass spectrum. (auth) (UK)

45749 PION–NUCLEON PHASE SHIFTS BELOW 270 MeV. Nielsen, H. (Univ. of Aarhus, Denmark). Nucl. Phys.; B30: No. 2, 317-32(1971).

Pion-nucleon phase shifts below 270 MeV are derived from fixed t-dispersion relations using as input the π^+p total cross sections measured by Bugg et al. below 290 MeV and CERN phase shifts above that energy. No particular high-energy model is needed. It is pointed out that the predicted d-wave phase shifts—in contradiction to those belonging to earlier phase-shift solutions—are in good agreement with partial-wave dispersion relations and recent information on the helicity amplitudes describing the process $\pi\pi \rightarrow N\bar{N}$. Furthermore the prediction for the P_{13} wave has very recently got strong support from the work by Bugg et al. on pion-nucleon charge-exchange scattering. (auth)

45750 MONTE-CARLO METHOD FOR MULTI-REGGE REACTIONS. Kopylov, G. I.; Penev, V. N.; Tevzadze, Yu. V.; Shklovskaya, A. I. (Joint Inst. for Nuclear Research, Moscow). Nucl. Phys.; B30: No. 2, 398-412(1971).

The relation is analyzed between the Byckling–Kajantie method of generation of peripheral random events and the usual methods of generation of central-interaction events. The way to ameliorate the efficiency of the method is proposed and tested. (auth)

45751 INVESTIGATION OF THE $I = 2\rho\pi$ SYSTEM IN $\pi N \rightarrow \rho\pi N$. Winkelmann, F. C. (Stanford Linear Accelerator Center, Calif.); Mickens, R. E.; Lubatti, H. J. Contracts AT(30-1)-2098; AT(04-3)-515. Nucl. Phys.; B30: No. 2, 535-44(1971).

The $I = 2\rho\pi$ system produced in the reaction $\pi^-n \rightarrow \rho^-\pi^-p$ is investigated within the framework of the Reggeized charge exchange Deck mechanism. The diagram in which a π and ρ are exchanged gives rise to an enhancement in the $\rho\pi$ effective mass at 1.1 GeV which is nearly independent of beam energy. Experimental evidence for such a state in $\pi^-n \rightarrow \rho^-\pi^-p$, and in the related processes $\pi^+n \rightarrow \rho^0\pi^0p$ and $\pi^-p \rightarrow \rho^-\pi^-\Delta^{2+}$ is discussed. The interpretation of this enhancement as an exotic state on the basis of the duality argument made by Chew and Pignotti is considered. (auth)

45752 UNSUBTRACTED DISPERSION SUM RULE AND $\pi\Lambda\Sigma$ COUPLING CONSTANT. Singh, C. P. (Allahabad Univ., India). Phys. Rev., D; 4: No. 1, 270-2(1 Jul 1971).

The $\pi\Lambda\Sigma$ coupling constant is determined by testing the sum rule which follows from the hypothesis of asymptotic conservation of s-channel helicity, and from the hypothesis that the P′ Regge trajectory decouples from the A^+ amplitude in $\pi\Sigma$ and $\pi\Lambda$ diffraction scattering. (auth)

45753 COULOMB CORRECTIONS TO ONE- AND TWO-CHANNEL STRONG SCATTERING PROCESSES. Auvil, P. R. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 4: No. 1, 240-7(1 Jul 1971).

Previous considerations of Coulomb corrections are generalized to single-channel processes to the two-channel case. Using a potential model, an extremely simple formula is derived for the corrections which does not necessitate using Coulomb wave functions. This formula is correct to lowest order in α but to all orders of the strong scattering. The application of the results to recent data on pion–nucleon elastic and charge-exchange scattering in the vicinity of the N*(1236) resonance is discussed. The choice of an appropriate wave equation and the question of mass-difference corrections are also discussed in an appendix. (auth)

45754 NOTE ON THE MOST PROBABLE NUMBER OF PARTONS IN PARTON MODELS. Gardiner, C. W. (Univ. of Waikato, Hamilton, New Zealand); Majumdar, D. P. Phys. Rev., D; 4: No. 1, 259-61(1 Jul 1971).

From analysis of the inelastic e–p scattering data it is found that an important feature of the parton probability function P(N) is that it should be peaked around some small number of partons. The most probable number of partons is prognosticated to be around 4.5. Contrary to the usually accepted forms of P(N), where it decreases uniformly from a maximum, it is found that the data also allow a behavior of P(N) where it rises to a maximum first and then decreases with increase of N. It is conjectured that there is a connection between this peaking and the observed peaking of the multiplicity distribution in inelastic collisions. (auth)

45755 EXISTENCE OF A BARYON ANTIDECUPLET. Golowich, E. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 4: No. 1, 262-4(1 Jul 1971).

The possibility that baryon antidecuplets exist in nature is discussed in the context of certain recent experimental results, and it is concluded that current data are consistent with this possibility. Analysis of long-range elastic forces in meson–baryon systems suggests that an antidecuplet may have spin–parity $\frac{1}{2}^+$. (auth)

45756 VENEZIANO MODEL FOR $K^-p \rightarrow K^{*-}\pi^+n$ AND $K^-p \rightarrow \bar{K}^{*0}n$ TAKING SOME ACCOUNT OF SPIN. Adjei, S. A.; Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 4: No. 1, 229-33(1 Jul 1971).

A Veneziano amplitude for $K^-p \rightarrow K^{*-}\pi^+n$, which takes the spin of the external particles into account, is constructed. From this amplitude an amplitude for $K^-p \rightarrow \bar{K}^{*0}n$ is obtained. Comparisons with the data for both processes are made. (auth)

45757 REGGE CUTS IN THE VAN HOVE MODEL: PION–NUCLEON FORWARD CHARGE-EXCHANGE SCATTERING. Holden, J. P.; Robertson, D. C. (Univ. of Oregon, Eugene). Phys. Rev., D; 4: No. 1, 233-6(1 Jul 1971).

A Regge pole-cut model based on the Durand–Van Hove model is presented for forward pion-nucleon charge exchange. Moving cuts are introduced through the j dependence of the mass of the exchanged spin-j object. The model fits the differential cross sections quite well. The polarization predictions are quite distinct from the Reggeized absorption model, and polarization measurements at $t = -0.5$ GeV^2 will be decisive between these two models. (auth)

45758 POMERANCHUK DOMINANCE OF THE IMAGINARY PART OF THE K^+p ELASTIC AMPLITUDE. Bander, Myron; Stone, Theodore M. (Univ. of California, Irvine). Phys. Rev., D; 4: No. 1, 248-50(1 Jul 1971).

Using a phase-shift solution for K^+p scattering, it is found that $\mathrm{Im}A'(\nu,t)$ is well described by a Pomeranchuk exchange in agreement with the Harari–Freund duality conjecture. (auth)

45759 NOTE OF CAUTION ON REGULARITIES IN THE BARYON SPECTRUM. Mitra, A. N. (Univ. of Delhi). Phys. Rev., D; 4: No. 1, 250-2(1 Jul 1971).

Some limitations on the regularities in the baryon spectrum suggested recently by Feynman et al. are discussed in the light of information on SU(3) mixing that can be provided by decay characteristics of "difficult" cases. It is argued that the roles of SU(3) mixing and spin–orbit effects could be largely complementary for an understanding of the baryonic spectrum. (auth)

45760 PREDICTIONS ON $\pi^- + p \rightarrow \rho^0 + n$ AND SOME RELATED PROCESSES USING VECTOR-MESON DOMINANCE. Cho, C. F. (Univ. of Chicago). Phys. Rev., D; 4: No. 1, 194-209(1 Jul 1971).

In the usual application of vector-meson dominance to analyze the process $\pi^- + p \rightarrow \rho^0 + n$, only the amplitudes for transversely polarized ρ are related to single-pion photoproduction. It is shown that both the longitudinal and the transverse amplitudes for the process $\pi^- + p \rightarrow \rho^0 + n$ can be obtained from single-pion photoproduction amplitudes by assuming that the off-shell Ball amplitudes not only satisfy the constraints imposed by current conservation, but also are smooth in the vector-meson mass. The

smoothness assumption is discussed in particle-exchange models in detail. The predictions are extended to somewhat larger $|t|$ than in our previous work, and comparison is made with recent 15-GeV SLAC data on $\pi^- + p \rightarrow \rho^0 + n$. The same assumptions are applied to analyze some related processes such as the electroproduction of a charged pion. (auth)

45761 FIRST-ORDER SU_3 CORRECTIONS TO MESON–BARYON COUPLING CONSTANTS. Gomberoff, L.; Grossman, Z. (Tel-Aviv Univ., Israel). Phys. Rev., D; 4: No. 1, 173-6 (1 Jul 1971).

Regge theory and some aspects of duality are used in order to parametrize the meson–baryon coupling constants, including first-order SU_3-breaking effects. Five of the more relevant coupling constants are expressed in terms of three unknown constants, yielding two independent sum rules. An estimate of corrections due to SU_3 mass shifts is suggested. (auth)

45762 CUT-CORRECTED EXCHANGE DEGENERACY AND THE KN-$\bar{K}$N CEX CROSS-SECTION INEQUALITY. Gage, D. W.; O'Donovan, P. J. (Arizona State Univ., Tempe). Nuovo Cim.; 4A: No. 2, 229-42(21 Jul 1971).

Consequences of cut-corrected exchange degeneracy are examined in the context of a model in which exchange-degenerate poles satisfying factorization and SU_3 are "corrected" by multiple-scattering "unitarity" cuts. Satisfactory agreement with the unequal KN and $\bar{K}$N CEX cross sections is obtained above 2 GeV/c for moderate t-values. RR cuts, fixed by the pole terms, are essential. It is shown that, contrary to recent contentions, the energy dependence of the cross section difference is easily accommodated in this cut scheme. (auth)

45763 TRIPLE REGGE BEHAVIOR IN INCLUSIVE REACTIONS. Chlyapnikov, P.; Czyzewski, O.; Finkelstein, J.; Jacob, M. (CERN, Geneva). Phys. Lett.; 35B: No. 7, 581-4(19 Jul 1971).

Prominent features associated with a triple Reggeon formula are found to meet the low momentum transfer domain of the $K^+p(K^0)$ inclusive reaction. (auth)

45764 πN CHARGE EXCHANGE POLARIZATION AND THE VIOLATION OF THE POMERANCHUK THEOREM. Schiff, D.; Yabuki, H. (Univ. of Maryland, College Park). Phys. Lett.; 35B: No. 7, 589-91(19 Jul 1971).

The violation of the Pomeranchuk theorem is shown to induce an energy trend for the small-t $\pi^-p \rightarrow \pi^0n$ polarization which may differ notably from the conventional model predictions already in the range $20 < p_{lab} < 50$ GeV. (auth)

45765 $\bar{K}$N INTERACTION IN THE REGION 0 TO 1200 MeV/c AND HYPERON RESONANCES. Kim, Jae Kwan (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 27: No. 6, 356-60(9 Aug 1971).

A multichannel phase-shift analysis is performed for the first time on the available experimental data of all the channels of $\bar{K}$N interactions in the momentum region 0 to 1200 MeV/c. The Argand diagrams of the reaction amplitudes and the resonance parameters within the momentum region are given. The results provide stronger evidence for a number of previously suggested resonances and also indicate some new possible resonances. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 45909 and 46104.

45766 (INR-P-1281) ROLE OF THE FORM OF THE HYPERNUCLEUS WAVE FUNCTION IN THE $^9Be \rightarrow \alpha + \alpha + p + \pi^-$ DECAY. Chlebowska, Daniela; Zielinska-Pfabe, Malgorzata (Institute of Nuclear Research, Warsaw (Poland)). 1971. 9p. Dep. NTIS (U. S. Sales Only).

The energy and angular distributions of the $^9Be \rightarrow \alpha + \alpha + p + \pi^-$ decay products are calculated with the use of ^9Be wave function in the form $g_{\alpha\alpha}(r_{\alpha\alpha})\, g_{\alpha\Lambda}(r_{\alpha_1\Lambda})\, g_{\alpha\Lambda}(r_{\alpha_2\Lambda})$. Two maxima corresponding to the 0+ and 2+ states of ^8Be are obtained in the α–α relative energy distribution in agreement with the experimental data. (auth)

45767 (JINR–E2-5827) ACCOUNT OF CLOSED LOOPS AND RELATIVISTIC EIKONAL REPRESENTATION. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. M.; Pervushin, V. N.; Sisakyan, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 16p. Dep. NTIS (U. S. Sales Only).

An attempt was made to apply a simplified version of the straight-line paths approximation to the case of a wider class of Feynmann graphs. It is shown that in the framework of the approximation used the scattering amplitude has the eikonal form. (auth)

45768 (JINR–P1-5807) ON THE INCREASE OF THE TOTAL CROSS SECTION OF COHERENT PROCESSES ON NUCLEI. Grishin, V. G.; Yuldashev, B. S.; Jancso, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the increase of the coherent-process cross section with increasing energy can be explained, in the main, by kinematic factors. (auth)

45769 MODELS FOR MESON–DEUTERON SCATTERING IN THE RESONANT REGION. Landau, Rubin Harold. Urbana, Ill.; Univ. of Illinois (1970). 181p. University Microfilms Order No. 71-14,839.

Thesis.

The Watson formulation of multiple scattering theory is derived and then employed to build a model for meson-deuteron scattering. The Glauber theory is also derived as an approximate form of multiple scattering theory. The developed model extends the Glauber description to regions in which the meson-nucleon cross section varies rapidly or resonates, by including effects caused by the nucleons' Fermi momenta, nonforward intermediate scattering, and off-energy shell scattering. It is concluded, after a numerical analysis, that Glauber theory itself could generate the large oscillations in $\langle r^{-2}\rangle_d$ reported in the analysis of π^+d total cross sections around 1 GeV/c and could introduce small peaks into the deduced I = 0 channel of the k^+n cross section. Nevertheless, for the previous k^+d data, conclusions drawn by following the usual folding procedures are not altered significantly by this model. The importance of different possible definitions of center-of-mass energy for off-shell scattering is also examined. It is shown that this choice of "s" does not affect total cross section calculations, but must be considered in the analysis of large angle scattering. (Diss. Abstr. Int., B)

45770 LAMBDA BINDING ENERGY FOR THE 2s–1d-SHELL HYPERNUCLEI. I. $18 \leq A \leq 21$. Lee, T. Y.; Hsieh, S. T.; Yeh, W. W.; Chen-Tsai, C. T. (Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 4: No. 1, 64-7(Jul 1971).

The Λ binding energies of the 2s–1d-shell hypernuclei with mass number between 18 and 21 are calculated by using the results of a shell-model calculation for the 1p-shell hypernuclei previously carried out by the authors [Phys. Rev. C, 2: 366(1970)]. (auth)

45771 MUON-PAIR PRODUCTION IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Sanda, A. I. (Columbia Univ., New York); Suzuki, Mahiko. Phys. Rev., D; 4: No. 1, 141-5 (1 Jul 1971).

Using a current-algebra sum rule derived from an equal-time commutator between charge densities, a lower bound was set on the muon-pair production cross sections. In spite of the fact that the estimate is conservative, the lower bound turns out to be very large at energies larger than ~100 GeV ($\gtrsim 0.50 \times 10^{-30}$ cm^2 at 500 GeV, the maximum available energy at the National Accelerator Laboratory). Comparing it with recent experimental data at lower energies, it is predicted that the muon-pair production cross section will keep increasing until it turns over owing to higher-order electromagnetic interactions through unitarity. (auth)

45772 Λ-HYPERON–α-PARTICLE SCATTERING. Khrylin, B. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: No. 5, 1005-7(May 1971). (In Russian).

Parameters of the low-energy $\Lambda\alpha$ scattering are calculated. (auth)

45773 MODEL-INDEPENDENT DETERMINATION OF THE REAL PARTS OF THE SPIN-INDEPENDENT AMPLITUDES IN THE FORWARD pp SCATTERING. Dumbrais, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1096-1101(May 1971). (In Russian).

A new method to analyze the experimental data on the proton–proton scattering is used to determine accurately the real parts of the forward scattering amplitudes in the momentum range $0.5 \text{ GeV/c} \leq k \leq 39 \text{ GeV/c}$. The method exploits the known analyticity properties of the scattering amplitude and experimental data in a limited energy range. However, unlike conventional dispersion relation calculations, it requires no assumptions about the amplitudes in the unphysical and asymptotic regions and about the π pole. Discrepancies between the experimental values of the real parts and earlier dispersion relation predictions in the momentum range $1.0 \text{ GeV/c} \leq k \leq 2.0 \text{ GeV/c}$ are confirmed. (auth)

45774 SOLVABLE MODEL FOR HIGH-ENERGY SCATTERING. Calucci, G.; Jengo, R.; Rebbi, C. Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim.; 4A: No. 2, 330-48(21 Jul 1971).

A Hamiltonian model is introduced to describe high-energy scattering and production. An approximation of the eikonal type is used to deal with the kinematic term of the colliding particles,

and, within this approximation, the scattering problem is solved exactly. Unitarity is satisfied both for the elastic and the inelastic amplitudes. A comparison of the prediction of the model with some experimental data for p−p scattering is presented. (auth)

45775 COMPARISON OF AN INCLUSIVE MULTIPERIPHERAL MODEL TO SECONDARY SPECTRA IN p−p COLLISIONS. Risk, Clifford (Univ. of California, Berkeley. Univ. of California, Davis); Friedman, Jerome H. Phys. Rev. Lett.; 27: No. 6, 353-6(9 Aug 1971).

The quantitative predictions of an inclusive multiperipheral model are compared with the measured secondary spectra in pp collisions from 12 to 30 GeV/c. (auth)

Particle Invariance Principles and Symmetries

General

45776 (ITEF-797) VIOLATION OF INVARIANCE. A REVIEW. Nikolaev, N. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 98p. (In Russian). Dep. NTIS (U. S. Sales Only).

A review of the present state of the problem of violation of invariance is presented. (K.S.W.)

45777 (ITF-71-10P) CLEBSCH-GORDAN COEFFICIENTS OF THE GROUP SL(2,C). Gavrilik, A. M. (Akademiya Nauk Ukrainskoii SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The exact expressions for the Clebsch−Gordan coefficients of the irreducible unitary representation tensor product of the group SL (2,C) of the principal and supplementary series are obtained. (auth)

45778 (LNF-71/18) OPERATOR PRODUCT EXPANSIONS AND NONLINEAR REALIZATION OF THE CONFORMAL GROUP. Ferrara, S.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 4 May 1971. 6p. Dep. NTIS (U. S. Sales Only).

The implications of the recently proposed nonlinear realization of the conformal group on operator product expansions at short distances are discussed and the role of logarithmic terms is pointed out. (auth)

45779 (ORO-3992-22) ON THE INDUCED REPRESENTATIONS OF THE (1 +4) DE SITTER GROUP AND THEIR REDUCTIONS. Stroem, Staffan (Texas Univ., Austin. Center for Particle Theory). Aug 1970. 35p. (CONF-700656-1). Dep. NTIS.

From Symposium on de Sitter and conformal groups; Boulder, Colo. (29 Jun 1970).

A survey is given of those aspects of the representation theory of $\overline{SO_0(1,4)}$ (The notation $\overline{SO_0(1,n)}$ denotes the universal covering group of the group SO(1,n) of real linear homogeneous transformations of $(x_0^2-x_1^2-\ldots-x_n^2$ invariant and which are continuously connected to the identity) which are obtained from the induction procedure. Some structural properties of a sufficiently general class of Lie groups are briefly reviewed which are used in the construction of the induced representations. The quaternion matrix group is introduced, and some details of the induced representations of $\overline{SO_0(1,4)}$ are given. Also an alternative way of decomposing the representations is given together with the transformation connecting the two basis systems involved. (J.F.P.)

45780 MASSLESS PARTICLES WITH INFINITE SPIN. Murphy, Joseph Erric. New York; City Univ. of New York (1971). 76p. University Microfilms Order No. 71-16,538.

Thesis.

Massless particles with infinite spin are investigated from a group theoretic viewpoint, and a quantum field theory to describe them is constructed. Momentum-helicity basis vectors are given along with their behavior under Poincaré transformations. The transformation to an angular momentum basis is given, and it is shown how to construct states localized in two dimensions. Reducible free fields of massless particles with infinite spin, transforming covariantly under the Poincaré group, are constructed. The fields are linear combinations of annihilation and creation operators for massless particles summed over all possible spin values. Some sufficient conditions for satisfying the causality requirement are given, and no necessary connection between spin and statistics is found. Fermi and Bose fields can be quantized so as to satisfy causality with or without the usual spin-statistics relation. Covariant propagators are exhibited for these fields, and scattering amplitudes are calculated in lowest order for two interaction Lagrangians. (Diss. Abstr. Int., B)

45781 CHIRAL SU(3) x SU(3) BREAKING. Barnes, K. J.; Dittner, P.; Dondi, P. H. (Queen Mary Coll., London). Nucl. Phys.; B31: No. 1, 195-203(1971).

The (3, 3*) + (3*, 3) phenomenology for the breaking of chiral SU(3) × SU(3) is derived from simple postulates suggested by the PCAC hypothesis. This derivation is explicitly constructive in nature and therefore, besides giving a new viewpoint for symmetry breaking, is of immediate utility. (auth)

45782 FIELD ALGEBRA AND SYMMETRY BREAKING. Gottlieb, H. P. W.; MacFarlane, A. J. (Cambridge Univ., Eng.). Nucl. Phys.; B31: No. 1, 125-40(1971).

The prescription is derived for introducing symmetry breaking effects, including mass splitting and mixing, into the algebra of fields in such a way as to retain not only a complete current algebraic scheme but also current divergence conditions. When spectral sum rules are saturated by physical one-particle vector meson states, they are identically satisfied in view of the algebraic structure of the theory. The nonet case is treated more generally than previously and a new parameter, amenable to experimental determination, enters the description of $\phi-\omega$ mixing. (auth)

Applications (Electromagnetic and Weak)

45783 TEST OF THE $\Delta S = \Delta Q$ SELECTION RULE IN K^0_{e3} DECAY. Mantsch, Paul Matthew. Urbana, Ill.; Univ. of Illinois (1970). 75p. University Microfilms Order No. 71-14,857.

Thesis.

An experiment was performed at the Argonne ZGS to test the validity of the $\Delta S = \Delta Q$ weak interaction selection rule for the decay $K^0(\overline{K}^0) \rightarrow \pi^{\pm}e^{\mp}\nu$. K^0 mesons were produced by a 3-GeV π^- beam on a carbon target in the reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$. Events were reconstructed on the basis of the trajectories of the kaon decay products in optical spark chambers located in a magnetic field. The electron from the decay was identified by its shower in heavy plate spark chambers. The presence of the associated Λ^0 was deduced from its decay $\Lambda^0 \rightarrow \pi^- + p$ in spark chambers near the target. Decay times for the K^0's were measured over a proper time interval of 0.5 to 6.5 K^0_S lifetimes from production. Decay time distributions for both signs of the decay lepton were corrected for geometrical efficiency and fit to theoretical distributions. The complex quantity x, determined from the fit, measured the magnitude and phase of the ratio of $\Delta S = -\Delta Q$ to $\Delta S = \Delta Q$ decay amplitudes. A nonzero magnitude for x would imply a violation of the $\Delta S = \Delta Q$ rule, whereas an imaginary part for x would reveal a violation of T and hence CP invariance. The results of the experiment based on 342 events are: Re $x = -0.05 \pm 0.12$, Im $x = -0.13 \pm 0.11$. These results are completely consistent with no violation of the $\Delta S = \Delta Q$ rule or of T invariance. (Diss. Abstr. Int., B)

45784 T, P, AND C SYMMETRIES IN $K_{L,S} \rightarrow \gamma\gamma$. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 4: No. 1, 267-9(1 Jul 1971).

The Bernstein−Michel analysis of $\pi^0 \rightarrow \gamma\gamma$ is applied to the decays $K_{L,S} \rightarrow \gamma\gamma$. It is shown that, in contrast to the situation in $\pi^0 \rightarrow \gamma\gamma$, a hypothetical violation of CP invariance in $K_{L,S} \rightarrow \gamma\gamma$ can, in principle, be detected by a measurement of the circular polarization of one of the two photons. (auth)

45785 BOUND ON CP NONCONSERVATION IN $K_L \rightarrow 2\gamma$ DECAY. Farrar, Glennys R.; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 1, 257-9(1 Jul 1971).

The surprisingly small upper bound recently established for $K_L \rightarrow \mu^+ + \mu^-$ decay is exploited, via unitarity, to set an upper bound on K_L decay to a two-photon state with spin−parity 0^+. Special circumstances operate here to lend a fair degree of credibility to the analysis. The fraction of $K_L \rightarrow 2\gamma$ decays which proceed in this CP-nonconserving mode is less than ~0.37. (auth)

45786 (1,8)+(8,1) TERM IN SU(3) × SU(3) SYMMETRY BREAKING AND THE PARAMETER ξ OF K_{l3} DECAY. Schilcher, K. (American Univ., Beirut). Phys. Rev., D; 4: No. 1, 237-9(1 Jul 1971).

An estimate of the magnitude of the SU(3) × SU(3) symmetry-breaking term transforming as (1,8)+(8,1) is made using pole dominance in spectral-function sum rules. It is found that the corresponding parameter ω is probably not small as commonly

believed, but approximately −1. The results are applied to K_{l3} decay, where the symmetry-breaking scheme discussed in conjunction with "weak partial conservation of axial-vector current" implies large negative values of ξ. (auth)

45787 U(3) × U(3) BREAKING AND 2 γ-DECAYS OF PSEUDOSCALAR MESONS. Strocchi, F. (Scuola Normale Superiore, Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Caffarelli, R. Vergara. Phys. Lett.; 35B: No. 7, 595-8(19 Jul 1971).

The physical consequences of a U(3) × U(3) breaking term $\epsilon\delta$ in the Hamiltonian $H = H_0 + \epsilon\delta + \epsilon_i u_i$ are investigated. Mass formulas are obtained and the $\eta - \eta'$ mixing is shown to be governed by this term. The 2 γ-decays of pseudoscalar mesons are computed by using the above Hamiltonian. A significant test is the prediction of a very small rate $E(1422) \to 2\gamma$. (auth)

Applications (Strong)

Refer also to abstract 45743.

45788 CHIRAL SYMMETRY BREAKING AND LOW ENERGY ππ SCATTERING. Brehm, J. J. (Univ. of Massachusetts, Amherst). Phys. Lett.; 35B: No. 7, 592-4(19 Jul 1971).

A method is presented for the use of s-wave ππ data in obtaining direct information related to the SU(3) × SU(3) symmetry breaking hamiltonian. Analytic hard pion methods are used to show how to obtain this information from the slopes of $(P/\sqrt{t})\cot\delta_T$ versus P^2 for T = 0 and 2. (auth)

45789 COUPLING OF VECTOR AND AXIAL-VECTOR MESONS IN BROKEN CHIRAL SU(3) x SU(3). Barnes, K. J.; Dittner, P. (Queen Mary Coll., London). Nucl. Phys.; B31: No. 1, 183-94 (1971).

By using a new technique, based on octet transforming axial divergences, the $(3, \bar{3}) \oplus (\bar{3}, 3)$ symmetry breaking of chiral SU(3) ⊗ SU(3) is explicitly realized to lowest orders on vector and axial vector mesons interacting with pseudoscalar mesons. (auth)

Field Theories

General

45790 (JINR-P2-5798) CONNECTION BETWEEN THE DIRAC AND THE MAXWELL EQUATIONS. Pestov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown, that in the Dirac equations over the Clifford algebra the Maxwell equations and some other field equations are contained. The connection between the duality rotation for the neutrino and electromagnetic fields is established. (auth)

45791 CLASSIFICATION OF THE RICCI TENSOR. Ludwig, Garry; Scanlan, Gerry (Univ. of Alberta, Edmonton). Commun. Math. Phys.; 20: No. 4, 291-300(1971).

A classification of the Ricci tensor $R_{\alpha\beta}$ is presented. The method of derivation is analogous to the spinor version of the Petrov classification of the Weyl tensor. It is shown how the various classes are related to the number and type of eigenvectors and eigenvalues of $R_{\alpha\beta}$. The classification is useful in the geometrization of various fields. The case of a real scalar field is treated in detail. (auth)

45792 ELECTROMAGNETIC SOLUTIONS OF THE FIELD EQUATIONS IN PRESENCE OF ZEROMASS MESONS. Misra, R. M.; Pandey, Deo Bhushan (Univ. of Gorakhpur, India). Commun. Math. Phys.; 20: No. 4, 324-31(1971).

The field equations of general relativity with electromagnetic stress tensor and zeromass scalar meson field are investigated. The metric coefficients are assumed to be functions of three variables only. It is then shown that, if one assumes a functional relation between some one of the metric coefficients and the electromagnetic potentials, that one can find a solution of the coupled Einstein–Maxwell equations in terms of a solution of the Einstein equations with zeromass scalar meson field as source. (auth)

Quantum Field Theory

Refer also to abstracts 45780, 45821, and 45822.

45793 (ITF-70-99, pp 15-40) RENORMALIZATION CONSTANTS AND INTERRELATION OF FUNDAMENTAL FORCES. Salam, Abdus (International Centre for Theoretical Physics, Trieste (Italy). Imperial Coll. of Science and Tech., London (England)).

In Fundamental problems of the elementary particle theory.

The interplay of the renormalization constants and the possibility that with some further assumptions there might emerge connecting relations among them are considered qualitatively for strong, weak and gravitational interactions. (J.F.P.)

45794 (ITF-70-99, pp 41-58) RECENT DEVELOPMENTS IN NONLOCAL AND ESSENTIALLY NONLINEAR FIELD THEORY. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR)).

In Fundamental problems of the elementary particle theory.

This review of the problems of nonlocal and nonlinear quantum field theory covers the main problem of the nonlocal or essentially nonlinear theory, the nonlocal cut-off algorithm, generalization of the T product, the Yolkov superpropagator, and essentially nonlinear fields. (J.F.P.)

45795 (JINR-E-2-5833) APPROXIMATE METHOD OF SOLVING THE QUASIPOTENTIAL EQUATIONS. Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. Dep. NTIS (U. S. Sales Only).

An approximate method of solving the quasipotential equations for the scalar particle scattering amplitude is developed. An example is given how the obtained approximate solution can be used. (auth)

45796 (LNF-71/16) EXPERIMENTAL TEST OF QUANTUM ELECTRODYNAMICS BY 2γ ANNIHILATION AT 1.4 TO 2.4 GeV TOTAL ENERGY WITH THE e^+e^- STORAGE RING ADONE. Bacci, C.; Baldini-Celio, R.; Capon, G.; Mencuccini, C.; Murtas, G. P.; Penso, G.; Reale, A.; Salvini, G.; Spinetti, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 3 May 1971. 20p. Dep. NTIS (U. S. Sales Only).

A test was made of the validity of quantum electrodynamics for a space-like electron propagator at high momentum transfers up to a maximum of 1.6 GeV. For the purpose of this test preliminary results are reported on the reaction $e^+ + e^- \to \gamma + \gamma$ at 2 × 0.7 to 2 × 1.2 GeV. The cross sections, angular distribution, and luminosity for these events are given. (J.F.P.)

45797 (NYO-3829-72) DIFFERENTIAL VERTEX OPERATIONS IN LAGRANGIAN FIELD THEORY. Lowenstein, J. H. (Pittsburgh Univ., Pa. Dept. of Physics). Jun 1971. Contract AT(30-1)-3829. 31p. Dep. NTIS.

A general framework is derived for studying differential operations in renormalized perturbation theory. The method makes possible a simple, unified derivation of the renormalization group and Callan–Symanzik equations, as well as a direct test for broken symmetries (including broken scale invariance), without the necessity of defining currents and deriving their generalized Ward identities. A second-order differential equation of the Callan–Symanzik type is derived using similar methods. (auth)

45798 SINGLE-PARTICLE STATE IN THE HIGHER SECTOR OF THE LEE MODEL. Gostev, V. B.; Mineev, V. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 1, 21-5(Jan-Feb 1969). (In Russian).

Studies of the behavior of a bound-state $\nu\theta$ propagator in a Lee model showed that in the case of a strong bond a single bound state and resonance appeared simultaneously in the elastic $\nu\theta$ scattering. Various peculiarities of the $\nu\theta$ scattering are discussed. (R.V.J.)

45799 ac-JOSEPHSON-EFFECT DETERMINATION OF e/h: A STANDARD OF ELECTROCHEMICAL POTENTIAL BASED ON MACROSCOPIC QUANTUM PHASE COHERENCE IN SUPERCONDUCTORS. Finnegan, T. F.; Denenstein, A.; Langenberg, D. N. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. B; 4: No. 5, 1487-1522(1 Sep 1971).

An ac-Josephson-effect determination of e/h with significantly improved accuracy is reported. The precision of the measurement is determined by uncertainties associated with the comparison of a Josephson-device voltage and the emf of an electrochemical-standard-cell voltage reference and is about 3 parts in 10^8. This precision was made possible by use of Josephson devices at voltages above 10 mV and design and construction of two special voltage-comparator instruments. The fabrication and operation of the Josephson devices and the design and performance of the voltage comparators are discussed. The $3/10^8$ precision represents the precision with which a drift-free and readily reproducible Josephson voltage standard can be realized in practice using the techniques developed for these experiments. The accuracy of the final result is about 12 parts in 10^8 and is determined primarily by un-

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certainties associated with the stability of the local electrochemical voltage standard and with establishment of the relationship between the local volt and the volt maintained by the U. S. National Bureau of Standards. Significant improvements in the maintenance of the local-voltage standard which contributed to reduction of the final uncertainty to this value are discussed. During the course of the experiments, the Josephson frequency-voltage relation was shown experimentally to be independent of magnetic field, temperature, and Josephson-device bias voltage or induced step number to within the accuracy of the final result. The final experimental result and its one-standard-deviation uncertainty are $2e/h$ = (483.593 718 ± 0.000 060) MHz/μV_{NBS69} (0.12 ppM) referred to the volt as maintained by the U. S. National Bureau of Standards. This result is in excellent agreement with the earlier, less accurate result which played an important role in the 1969 adjustment of the fundamental physical constants. It is in reasonable agreement with values recently reported by several other groups. The significantly improved accuracy of the present result makes possible a small improvement in the accuracy of the derived value of the fine structure constant and clears the way for a larger improvement through more accurate determination of the proton gyromagnetic ratio. (auth)

45800 SUM RULES FOR THE VERTEX FUNCTION FROM LOCAL COMMUTATIVITY. I. RELATIONS FOR THE VACUUM EXPECTATION VALUES (THE COORDINATE SPACE VERTEX FUNCTION). Andersson, Bo. (Univ. of Lund, Sweden). Nucl. Phys.; B30: No. 2, 413-28(1971).

A set of sum rules is derived based upon the analyticity properties of the Källén–Wightman holomorphy domain, i.e. essentially the assumptions of local commutativity properties for the occurring field operators, together with assumptions on boundedness properties of the vertex functions. The results are expressed as relations between the vacuum expectation values of the theory. (auth)

45801 SUM RULES FOR THE VERTEX FUNCTION FROM LOCAL COMMUTATIVITY. II. RELATIONS FOR THE CAUSAL BOUNDARY VALUES IN MOMENTUM SPACE. Andersson, Bo (Univ. of Lund, Sweden). Nucl. Phys.; B30: No. 2, 429-52 (1971).

The sum rules derived in an earlier paper are applied to the momentum-space boundary values of the vertex function and it is shown how to use the formulas to derive relations for the dynamical on-the-mass-shell quantities, i.e. the matrix elements of locally commuting field operators. (auth)

45802 SUM RULES FOR THE VERTEX FUNCTION FROM LOCAL COMMUTATIVITY. III. RELATIONS APPLICABLE TO THE TIME-ORDERED AND ANTI-TIME-ORDERED BOUNDARY VALUES OF THE VERTEX FUNCTION. Andersson, Bo (Univ. of Lund, Sweden). Nucl. Phys.; B30: No. 2, 453-65 (1971).

A set of sum rules, independent of the ones presented in two earlier papers, are derived from the analyticity properties of the vertex function proved by Källén and Wightman. The sum rules are applicable to the time-ordered and anti-time-ordered boundary values. In an explicit example it is shown how the relations can be combined to re-derive an earlier result by different methods. (auth)

45803 ELIMINATING SPURIOUS STATES FROM THE DUAL RESONANCE MODEL. Brower, R. C. (CERN, Geneva); Thorn, C. B. Nucl. Phys.; B31: No. 1, 163-82(1971).

Virasoro pointed out that the dual resonance model with trajectory intercept one ($\alpha_0 = 1$) has a larger number of linear dependences. Here a linearly independent basis for the spurious states at $\alpha(\pi^2) = N$ is constructed, and it is demonstrated that the remaining real states have the same mass (degeneracy), spin and parity as those states created by the spatial oscillators $a_n^\dagger$. The problem of eliminating ghosts (negative norm states resulting from $[a_{on}, a_{on}^\dagger] = -1$) is reformulated, and no ghosts or unanticipated null (zero norm) states are found on the leading nine trajectories. The projection operator onto the real subspace is calculated and the corrections to the single loop diagrams are obtained for orientable and nonorientable diagrams respectively. The sum of all single loop diagrams is expressed as a single integral. (auth)

45804 GAUGE INVARIANCE AND MASSLESS GAUGE PARTICLES IN SPINOR THEORY. Saller, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 4A: No. 2, 404-20(21 Jul 1971).

It is shown that gauge invariance in spinor theory — achieved by appropriate definition of the product of three ψ's at one space–time point — involves vector bosons of mass zero with the respective quantum numbers. These bosons are constructed explicitly in first approximation. (auth)

45805 GAUGE-INVARIANT INFINITY SUPPRESSION IN GRAVITY-MODIFIED QUANTUM ELECTRODYNAMICS. Isham, C. J. (Imperial Coll. of Science and Tech., London); Salam, A.; Strathdee, J. Phys. Lett.; 35B: No. 7, 585-8(19 Jul 1971).

It is argued that the use of a visibly localizable parametrization of the gravitational interaction yields a number of advantages. Firstly, the question of ambiguities can be completely solved: according to a theorem of Lehmann and Pohlmeyer there exists in such theories a unique "minimally singular" solution which it is natural to adopt as the physical one. Secondly, it is possible to show that this solution satisfies the usual requirements of analyticity and unitary in the sense of perturbation theory. Thirdly, it is possible to arrange the computations in a manifestly gauge independent manner. (auth)

Gravitation and General Relativity

Refer also to abstract 44687.

45806 (AD–718957) QUANTUM BIANCHI IDENTITIES AND FIELD EQUATIONS FOR GENERAL RELATIVITY. Russo, M. (Northeastern Univ., Boston, Mass. Dept. of Physics). Dec 1970. Contract F33615-69-C-1207. 29p. (NUB–2042). NTIS.

By invoking the physical symmetry of coordinate invariance for the matter-free gravitational field, the contracted quantum Bianchi identities are derived from a family of Hermitian Lagrangians which are the quantum analogs of the Palatini Lagrangian. It is further shown that these gauge variational techniques yield a set of necessary conditions that determine whether the quantum field equations and contracted Bianchi identities contain purely quantum structures of order (Plancks constant/2π) squared which possess no quantum analogs. (auth) (USGRDR)

45807 (ITF–70–99, pp 4–14) ROLE OF GRAVITATION IN THE ELEMENTARY PARTICLE THEORY. Markov, M. A.

In Fundamental problems of the elementary particle theory.

The physical description for removing divergences in the theory by means of the gravitational field is considered. The classical theory and the quantum theory are discussed. (J.F.P.)

45808 LECTURES ON THE MODERN GRAVITATION THEORY. PART I. Perjes, Zoltan (Central Research Inst. for Physics, Budapest). Fiz. Szemle; 21: No. 2, 48-59(Feb 1971). (In Hungarian).

The theory of general relativity underwent wide development during the last few years: the mathematical problems involved in the travel of large masses through strong gravitational fields have been resolved; the concept of gravitational radiation field is better understood and new techniques have been developed to treat nonlinear Einstein equations. The problems discussed included derivation of the equation of motion from the Einstein equations, pointing out a specific application of the Einstein–Infeld–Hoffmann technique. The correspondence principle, involving the classical Newtonian concept and the general theory of relativity, was illustrated by comparing the Newtonian and Einsteinian gravitational constants. A number of recently described experimental techniques were described. (TTT)

45809 INTERACTION OF A HARMONIC OSCILLATOR WITH GRAVITATIONAL WAVES. Frehland, E. (Univ., Freiburg i. B.). Phys. Lett.; 35A: No. 6, 432-3(12 Jul 1971).

For a simple model of a harmonic oscillator the energy-momentum-stress tensor is determined and the energetic interaction with a plane gravitational wave of the same frequency is calculated. (auth)

45810 FORM FACTORS FOR GRAVITON–PARTICLE INTERACTIONS. Hare, M. G. (Univ. of Saskatchewan, Regina). Can. J. Phys.; 49: 1869-73(15 Jul 1971).

Contributions to the mass-energy form factors are calculated for the graviton–nucleon and graviton–deuteron (singlet and triplet) vertex interactions using sidewise dispersion relations. These factors are useful in astrophysics for vertex corrections to graviton–particle interactions. Electromagnetic contributions are considered for all vertices, π-meson contributions for the nucleon vertex and the two nucleon breakup for the singlet deuteron vertex. The deuterons are treated as elementary particles and the threshold region is assumed to dominate the results. (auth) (Canada)

45811 ACTION-AT-A-DISTANCE THEORY OF GRAVITATION. II. TENSOR INTERACTIONS. Volkov, A. B. (State Univ. of New York, Stony Brook). Can. J. Phys.; 49: No. 13, 1697-1707 (1 Jul 1971).

A previous paper showed that the classic tests of the general theory of relativity can all be explained in terms of a special

relativistic action-at-a-distance theory involving an appropriate mixture of a scalar and vector interaction. The theory was generalized to tensor interactions of all orders. The demands of special relativity and the perihelion advance of Mercury lead to a unique specification of the scalar interaction strength, but since the limit for all other tensors is the same for the perihelion advance (one sixth the general relativity result) only the sum of the interaction strengths can be determined for these tensors. Some possible physical consequences are discussed. (auth) (Canada)

45812 ALGEBRAICALLY SPECIAL EINSTEIN–MAXWELL FIELDS IN THE SPIN COEFFICIENT FORMALISM. Lind, Robert Wayne. Pittsburgh; Univ. of Pittsburgh (1970). 77p. University Microfilms Order No. 71-12,363.

Thesis.

The problem of finding algebraically special solutions to the vacuum Einstein–Maxwell equations is investigated using the spin coefficient formalism of Newman and Penrose. The general case in which the degenerate null vectors are not hypersurface orthogonal is reduced to a problem of solving five coupled differential equations that are no longer dependent on the affine parameter along the degenerate null directions. Equations of motion are obtained from the field equations using techniques that arise naturally in the theory of representations of the Lorentz group. These techniques are applied to a special case that yields equations of motion for a spinning particle and to the Robinson–Trautman–Maxwell case. Exact solutions of the Einstein–Maxwell equations are presented. (Diss. Abstr. Int., B)

45813 NEW APPROACH TO THE PROBLEM OF MOTION IN GENERAL RELATIVITY. Massa, Enrico (Univ., Genoa). Commun. Math. Phys.; 20: No. 4, 279-90(1971).

The dynamical meaning of the equations $T^{ij}_{\ ;j} = 0$ is derived as a consequence of the mathematical structure of Einstein's equations. A generalization of Lichnerowicz's analysis of the gravitational equations is proposed. (auth)

45814 SNELL'S LAW AND THE GRAVITATIONAL DEFLECTION OF A PHOTON. Tangherlini, F. R. (Coll. of the Holy Cross, Worcester, Mass.). Nuovo Cim., 4B: No. 1, 13-26(11 Jul 1971).

The particle picture of light in a gravitational field, described previously, is further developed to yield, by successive approximations, the exact particle Hamiltonian and the corresponding metric associated with the Schwarzschild field. The analysis is carried out in two co-ordinate systems, which checks general covariance for a special case and, in addition, clarifies the role played by gravitational self-energy. The previous derivation of the photon's effective mass in a refractive medium is simplified, and a derivation of the Hamiltonian based on the wave-particle complementarity is also presented. (auth)

45815 GENERAL-RELATIVISTIC SCALAR FIELD THEORY IN THE COMPLEX WEYL SPACE. Cherry, N. H. (Drexel Univ., Philadelphia). Nuovo Cim., 4B: No. 1, 144-63(11 Jul 1971).

Weyl's gauge postulate is extended to include the mass term in a complex space. A generally covariant equation and an equivalence relation are then introduced that unify the matter, electromagnetic and gravitational fields in this space. These expressions lead directly to the Klein–Gordon equations as well as to more general wave equations including those for pseudoscalar fields. Consideration is then given to the noninvariant terms under the gauge postulate and it is shown that these terms represent measurable quantities in the laboratory space. Einstein's free-space field equations are then developed within the context of this theory and the Yukawa problem is solved as an application of these equations. In addition to the Yukawa potential, two core potentials are obtained. Finally, Maxwell's free-space field equations are developed and the central-charge problem is solved as an application of this theory. (auth)

Scattering Theory

45816 (COO–1764-120) COMMENTS ON A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M. (Washington Univ., Seattle. Dept. of Physics); Coon, D. D. (Minnesota Univ., Minneapolis. Dept. of Physics and Astronomy). [1971]. Contracts AT(45-1)-1388; AT(11-1)-1764. 10p. Dep. NTIS.

Some features of the nonlinear trajectories of a dual multiparticle theory are examined and the development of the theory is discussed. (auth)

45817 (JINR–E4-5837) ON THE NUMBER OF RESONANCES OF NONLOCAL SEPARABLE POTENTIALS. Beregi, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. Dep. NTIS (U. S. Sales Only).

The possibility of including resonances into the quantum mechanical two-body systems with the help of nonlocal separable potentials is investigated. It is shown that the number of the resonances in contrast to the number of the bound states is not limited by the number of "attractive" terms contained in the nonlocal separable potentials, but it depends on the form factors. (auth)

45818 RELATED STATES AND SCATTERING IN A THREE-PARTICLE SYSTEM. Simenko, A. G.; Kharchenko, V. F. (Inst. of Theoretical Physics, Kiev). Usp. Fiz. Nauk; 103: No. 3, 469-527(Mar 1971). (In Russian).

The nonrelativistic theory of a three-particle system with pair interaction is examined. This is based upon the Faddeev formalism, utilizing the separable Gilbert–Smith idea for two-particle interaction. The Faddeev angular equations are reduced to a system of two-dimensional integral equations which become terminal for short-range nuclear forces. With the help of the Gilbert–Smith method there is introduced the separation concept of a two-particle matrix. The convergence of the Gilbert–Smith analysis for negative energy values was investigated, as well as the separation concept for local Hulthen potentials and a rectangular model. Elastic scattering was examined in a system of three identical spinless particles and in a system of three nucleons, and results are reported on related one-dimensional integral equations. The binding energy was determined for a three-particle system and scattering in a two-particle system and related states. Calculations showed a strong dependence of properties of the three-particle system on the model of two-particle interaction, even in the case of short-range acting forces, in contrast to the two particle system. The properties of the latter at small energies are practically insensitive in the two-particle interaction model. (tr-auth)

45819 IMPACT PARAMETER REPRESENTATION OF THE SCATTERING AMPLITUDE. Razavy, M. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: 1885-98(15 Jul 1971).

From the Lippmann–Schwinger equation, the exact and different approximate relations for the impact parameter form of the total scattering amplitude on- and off-the-energy shell are derived. The relation between the impact parameter phase shift and the range of potential is studied, and several methods of determining the potential from the impact parameter phase shift for local, nonlocal, and energy dependent interactions are obtained in Blankenbecler and Goldberger's approximation. By considering solvable examples it is shown that the Glauber approximation, in certain cases, may be valid for all scattering angles. Finally for completely elastic scattering or for a purely absorptive potential, methods of finding the impact parameter phase shift from the differential cross section for scattering are given. (auth) (Canada)

45820 NONRELATIVISTIC POSITIVE-α LANDAU SURFACES. Chandler, Colston (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 44: No. 1, 101-6(15 Feb 1971).

Results previously proved for relativistic positive-α Landau surfaces are extended to the nonrelativistic case. It is proved that in the physical region, at points where no two initial and no two final particle momenta are parallel, leading surfaces are real analytic submanifolds of codimension 1. The normal to a leading surface at a manifold point is proved to determine, in an essentially unique way, the Coleman–Norton space–time picture of the corresponding multiple scattering process. (auth)

45821 VVEDENIE V DIAGRAMMNUYU TEKHNIKU FEINMANA. (Introduction to the Feynman Diagram). Bilen'kii, S. M. Moscow; Atomizdat (1971). 216p.

Quantum theory describes particle interactions in which a number of particles may not be conserved. First the S-matrix is introduced as a fundamental transition-handling tool. Classical field, the Lagrange field, field quantization, Hamiltonian interaction, chronological and normal products of field operators, and the Wick theorem are also interjected as requisite accoutrements for subsequent development of the subject. Rules for constructing a Feynman diagram are amplified by examples of processes with participation of electrons, positrons, and gamma quanta. Considerable attention is given to particle scattering, effective cross sections, and particle disintegration reactions, using the Feynman diagram as an analytical tool. (K.S.W.)

45822 APPROXIMATION TO THE RELATIVISTIC SCATTERING PROBLEM. Lu, Pao; Measure, Edward M. (Arizona State Univ., Tempe). Phys. Rev., C; 4: No. 1, 31-5(Jul 1971).

The calculation of the relativistic phase-shift problem, as given before [Phys. Rev. C, 1: 468(1970)], is extended to second order in $\hbar$ by means of Miller and Good's modified WKB method [Phys. Rev. 91: 174(1953)]. The scheme of Bertocchi, Fubini, and Fur-

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lan [Nuovo. Cim., 35: 633(1962)] is used to avoid the divergences introduced in the second-order terms. The examples indicate that the phase shifts are greatly improved at lower angular quantum numbers. (auth)

45823 SCATTERING OF UNSTABLE PARTICLE. Lazarev, L. M. Yadern. Fiz.; 13: No. 5, 975-80(May 1971). (In Russian).

The Feshbach formalism is applied to investigate analytical properties of the scattering amplitude of three stable particles 1, 2, 3 near zero energy of the system, unstable particle production threshold $Y^* \rightleftharpoons 2 + 3$ and scattering resonance $1 + Y^*$. The results obtained are necessary when choosing a unique solution in the phase shift analysis and applied to explain the effects of the parameter violation of quasistationary levels Y^* in reaction $a + A \rightarrow X^* \rightarrow 1 + Y^* \rightarrow 1 + 2 + 3$ as compared to analogous parameters in two-particle resonance scattering $2 + 3 \rightleftharpoons Y^*$. (auth)

45824 NUMERICAL COMPUTATIONS IN THE INVERSE-SCATTERING PROBLEM AT FIXED ENERGY. Sabatier, Pierre C.; Quyen Van Phu, F. (Univ., Montpellier, France). Phys. Rev., D: 4: No. 1, 127-32(1 Jul 1971).

Constructing potentials from the phase shifts at a given energy yields an infinity of equivalent solutions. The deviations of these solutions from each other can, however, be analyzed according to a priori limitations on the derivatives and other features of "acceptable" potentials. A sketch of this analysis is given together with a numerical comparison of usual potential forms with the equivalent potentials obtained through Newton's method. The observed deviation gives an appraisal of the deviations from each other of all the equivalent potentials with similar bounds on the derivatives. The deviation is small when there are many phase shifts available, all of them definitely smaller than $\pi/2$. For a static potential these conditions can be met for high energies. (auth)

45825 REGGE POLES AND BOUND STATES OF NONRELATIVISTIC SCATTERING SYSTEMS. Kronenfeld, Richard (Arizona State Univ., Tempe). Amer. J. Phys.; 39: No. 9, 1056-68 (Sep 1971).

A heuristic argument which avoids using the Sommerfeld–Watson transform is presented for the existence of bound states for a potential at the poles of its partial-wave scattering amplitude in the physical sheet. A general formula for bound state Regge trajectories is obtained from the Jost function $\phi^+(l, k^2)$, and it is applied to four potentials — Coulomb, harmonic oscillator, delta shell, and spherical well. Some properties of Regge trajectories in nonrelativistic scattering and the extension of Regge pole theory to relativistic particle interactions are examined. (auth)

45826 VARIATIONAL PRINCIPLES AND PADE APPROXIMANTS. BOUND STATES IN POTENTIAL THEORY. Alabiso, C. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan); Butera, P.; Prosperi, G. M. Nucl. Phys.; B31: No. 1, 141-62(1971).

In a previous paper a method was introduced for the determination of the bound states, consisting of applying the Padé-approximant technique to the perturbative expansion of the off-shell partial-wave amplitude and then treating the external momentum as a variational parameter. By application to the exponential potential, the method was shown to provide great improvement when compared with the more usual on-shell techniques. A rigorous justification of the heuristic procedure previously followed is attempted by a detailed study of the connection between PAs and variational methods in potential theory; in particular a specific convergence theorem is established. Numerical results on Yukawa and Coulomb potentials are also reported. (auth)

45827 COMMUTATORS AND SCATTERING THEORY. I. REPULSIVE INTERACTIONS. Lavine, Richard B. (Cornell Univ., Ithaca, N. Y.). Commun. Math. Phys.; 20: No. 4, 301-23(1971).

Commutators are used to find classes of operators which are smooth with respect to the Hamiltonian H for a system of quantum mechanical particles which repel each other. It follows that H is absolutely continuous, the wave operators are complete in many cases when they exist and limits of momentum observables as time approaches $\pm\infty$ exist even in cases where the long range of the interaction precludes existence of the wave operators. (auth)

45828 THE POLES, THE ZEROS, AND THE ASYMPTOTIC BEHAVIOUR OF A VENEZIANO AMPLITUDE. Wanders, G. (Univ., Lausanne, Switzerland). Nuovo Cim.; 4A: No. 2, 383-403(21 Jul 1971).

General properties of a meromorphic approximation of a scattering amplitude are investigated. The case of an amplitude with no u-channel poles and real, equally spaced, s-channel poles is considered. This amplitude is required to behave as a power of s as $s \rightarrow \infty$ outside the positive real axis. This determines the main features of the distribution of its s-channel zeros. Furthermore, if these zeros satisfy suitable uniformity conditions as functions of t, one finds that the exponent of s appearing in the s-channel asymptotic behavior cannot be an arbitrary function of t. This results from the polynomial character of the residues at the s-channel poles. In particular, if this exponent is assumed to be an entire function of t, it must be a linear function of t. Thus, the leading t-channel poles have to be on a linear trajectory and the s-channel asymptotic behavior has to be the Regge behavior associated with this trajectory. (auth)

45829 ANALYTIC RENORMALIZATION OF DUAL ONE-LOOP AMPLITUDES. Goddard, P. (CERN, Geneva). Nuovo Cim.; 4A: No. 2, 349-62(21 Jul 1971).

Off-mass-shell orientable nonplanar loops are used to suggest a specific way of regularizing one-loop amplitudes. The corresponding counterterms are complex because the pomeronlike singularity, present in orientable nonplanar loops, is a cut rather than a pole. (auth)

45830 DUAL-CURRENT AMPLITUDES WITH SPURIOUS STATES. Ademollo, M. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Gomis, J. Nuovo Cim.; 4A: No. 2, 299-329(21 Jul 1971).

The possibility of constructing a model for current amplitudes satisfying i) planar duality, ii) complete factorization, iii) the divergence conditions of CVC and current algebra, and iv) the absence of unphysical singularities is analyzed. The consistency of the points i), ii) and iii) requires the contribution of spurious states in the factorization of the two-current amplitudes. The point iv) is related to the off-shell extrapolation of the amplitudes and also shows the necessity of spurious states. It is therefore suggested that spurious states must have a physical interpretation in terms of hadrons. A specific model for the vector–current operator is then considered in detail. The relevant current amplitudes are shown to have a good behavior in the limit of zero-current momenta; the single-current amplitudes are dominated by the external line insertions and the two-current amplitudes satisfy the Ward–Takahashi divergence conditions. The two-current amplitudes, however, have a bad behavior for arbitrary momenta, and also show a violation of CVC due to the presence of spurious-pole contributions. (auth)

45831 TIME-DEPENDENT SCATTERING THEORY FOR LONG-RANGE INTERACTIONS. Prugovecki, E. (Univ. of Toronto). Nuovo Cim., 4B: No. 1, 105-23(11 Jul 1971).

A formulation of a time-dependent nonrelativistic scattering theory is given which is based exclusively on the asymptotic behavior in time of expectation values of observables. This leads in a natural way to the concepts of "physical" asymptotic states and wave operators, which are generalizations of their conventional "strong" counterparts. Basic properties of these quantities and their relation to their "renormalized" counterparts are derived. It is shown how this approach to scattering theory can supply a framework which incorporates scattering involving long-range potentials. (auth)

45832 INTEGRAL REPRESENTATIONS OF THE WAVE AND TRANSITION OPERATORS IN NONRELATIVISTIC SCATTERING THEORY. Prugovecki, E. (Univ. of Toronto). Nuovo Cim., 4B: No. 1, 124-34(11 Jul 1971).

Hilbert-space versions of the Lippmann–Schwinger equations for wave operators and the usual T-matrix formulas are derived by using the theory of Riemann–Stieltjes integrals of operator-valued functions with respect to spectral functions. These results are valid for the renormalized wave operators, which have to be introduced when the interactions are of long range. (auth)

Particle Accelerators

Refer also to abstracts 44536–44541, 44727, 45912, 45913, 45948, 46016, and 46021.

45833 (CERN–Trans–71-15) MEASUREMENT AND CORRECTION OF THE MAGNETIC FIELD OF THE A.F. IOFFE PHYSICO-TECHNICAL INSTITUTE (ORDER OF LENIN) 1 GeV SYNCHRO-CYCLOTRON. PART II. CORRECTING THE POSITION OF THE MEDIAN SURFACE. Abrosimov, N. K.; Eliseev, V. A.; Petrov, I. A.; Ryabov, G. A. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated by B. Hodge (CERN, Geneva, Switzerland), from report FTI–130. 11p. Dep. NTIS (U. S. Sales Only).

The synchrocyclotron's field parameters, which must be checked in order to restrict the axial motion of the accelerated particles, are discussed. An examination is made of the effect of the non-horizontal positioning of the PTI magnet's pole pieces on the values of the radial field component when measured with a vertically-oriented Hall detector. A procedure is described for correcting the position of the median surface. As a result of the work done, the deviation of the orbital plane of the particles from the mean geometrical plane due to the magnetic field does not exceed 1 cm, while distortion of the orbital plane is negligible (<1 mm). (auth)

45834 (COO-1760-4) SUMMARY REPORT ON CYCLOTRON UTILIZATION, OPERATIONAL ACHIEVEMENTS, AND IMPROVEMENTS DURING TWELVE MONTHS ENDING MAY 31, 1971. Technical Progress Report. (Washington Univ., St. Louis, Mo.). 15 Jul 1971. Contract AT(11-1)-1760. 24p. Dep. NTIS.

The development and operation of the cyclotron at Washington University from June 1, 1970 to May 31, 1971, are summarized. Accelerator operation time and utilization and beam parameters are tabulated; and peripheral developments and improvements are outlined. (W.H.K.)

45835 (IFVE-SKU-70-57) SYSTEM OF SLOW TARGETING OF ACCELERATED BEAM ON THE INTERNAL TARGETS OF 70 GeV ACCELERATOR. Gridasov, V. I.; Kardash, A. A.; Kozlov, K. M.; Kurnaev, O. V.; Lapin, V. V.; Lobanov, S. V.; Moizhes, L. L.; Myznikov, K. P.; Naumov, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

Principles and detailed description of the internal target system used at the IHEP accelerator are given. The system is for the generation of secondary particle beams with duration of more than 1 sec. The method of an artificial excitation of the magnetic field local inhomogeneity in the accelerator units is used. This method permits to extend radially an operational range of the targets. A density homogeneity of the ejected beams and supression of the time structure are achieved by means of a particle current feedback in the excitation system of the magnetic field asymmetry and by a wide frequency range of the power supply source. (auth)

45836 (IFVE-SKU-70-58) CHARACTERISTICS OF THE ACCELERATED PROTON BEAM AT THE 70 GeV ACCELERATOR. Gridasov, V. I.; Zelenov, B. A.; Zenin, V. A.; Myznikov, K. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Dependences of the amplitudes of radial-phase oscillations and the dimensions of an accelerated beam on its energy are defined. Distribution functions in the amplitudes of the radial and vertical betatron oscillations were found. This information on the beam is necessary to solve the problems connected with the particle ejections from the accelerator. (auth)

45837 (JINR-E-13-5796) NANOSECOND PULSED BEAM EXPERIMENTS AT THE HEAVY ION CYCLOTRON. Hagemann, U.; Neubert, W.; Schulze, W.; Stary, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 15p. Dep. NTIS (U. S. Sales Only).

The experimental arrangement has been installed at the 3 m heavy ion cyclotron in Dubna for performing spectroscopic in-beam measurements. By making use of the natural beam bunching, isomeric states with lifetimes down to 10 ns can be measured. The gamma radiation is detected by a planar Ge(Li) detector. (auth)

45838 (RISO-M-1386) HIGH-POWER MICROWAVE WATER LOAD FOR THE RISOE 10-MeV LINEAR ACCELERATOR. Hansen, Johnny (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1971. 20p. (In Danish). Dep. NTIS (U. S. Sales Only).

For absorption of the remaining power from the accelerator microwave system, a load was constructed with water as the absorbing medium. The water load consisted of a chamber filled with water separated from the rectangular waveguide transmission system by a ceramic window. The matching of the impedance of the water chamber to the waveguide impedance was performed by means of a single post obstacle within the waveguide. The water load was constructed for an average power of 3 kW and a peak power of 1.25 MW, with a maximum voltage standing wave ratio of 1.2. (auth) (Denmark)

45839 (RPP/R-8) A PION BEAM FOR RADIOBIOLOGICAL AND DOSIMETRIC STUDIES, USING A PROTON SYNCHROTRON EXTERNAL TARGET. Perry, D. R.; Hynes, M. A. (Rutherford High Energy Lab., Chilton (England)). [nd]. 9p. (CONF-710423-6). Dep. NTIS (U. S. Sales Only).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

A beam line primarily intended for radiobiological experiments with stopping negative pions has been constructed adjacent to one of the extracted proton beam targets of the 7 GeV proton synchrotron, Nimrod. The beam line transports particles of either sign with any required momentum up to 200 MeV/c. Thus pion beams are available for any tissue-equivalent range up to 30 cm. The beam line has to operate at 94° to the extracted proton beam in order to share a target with secondary beams of higher momentum operating at the same time. The solutions of the beam transport problems resulting from this arrangement are discussed. The beam line is designed to concentrate particles, within a selected momentum band, with reasonable uniformity over a 2 cm diameter area. Preliminary tests of the beam have now been performed, and confirm its suitability for radiobiological experiments at dose rates up to 20 rads per hour. The contamination of the beam, in terms of the relative absorbed dose caused by it at the pion peak, is estimated to be about 10% electrons, less than 3% muons and 1% neutrons when the primary proton target is 6mm × 6mm × 100mm of copper. (auth)

45840 (RPP/R-9) DISTRIBUTION OF DOSE AND INDUCED ACTIVITY AROUND EXTERNAL PROTON BEAM TARGETS. Levine, G. S.; Squier, Dorothea M.; Stapleton, G. B.; Stevenson, G. R.; Goebel, K.; Ranft, J. (Rutherford High Energy Lab., Chilton (England)). [1971]. 18p. (CONF-710423-4). Dep. NTIS (U. S. Sales Only).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

In this paper measurements of the flux density of hadrons and the energy deposition by the hadron and electromagnetic cascades around targets in the external proton beams of the CERN PS and Nimrod are described. These measurements are compared with predictions of Monte Carlo calculations. How these calculations and measurements can be used to predict the dose to personnel in an accident situation or the dose which can cause radiation damage and the gamma dose rates from radioactivity induced in components of present and future high energy accelerators are indicated. (auth)

45841 (SLAC-Trans-132) STABILITY OF THE PHASE MOTION OF MANY BUNCHES IN CHARGED-PARTICLE STORAGE RINGS. Karliner, M. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from report IYAF-45-70. 22p. Dep. NTIS.

The conditions for the stability of the phase motion of a large number of bunches in a relativistic storage ring when the beam interacts electromagnetically with the external system were investigated. For the most characteristic case of identical bunches whose number is equal to the radiofrequency factor, stability conditions are obtained in the form of a set of inequalities, each of which ensures the stability of the corresponding symmetric oscillation mode. The case of several bunches is analyzed in comparison with the case of a single bunch. An expression is given for the instability growth rates for symmetric modes. (auth)

45842 CYCLOTRON BEAM EXTRACTION SYSTEM. (to Cyclotron Corp.). British Patent 1,238,583. 7 Jul 1971. Priority date 12 Nov 1968, United States.

An electrostatic beam extraction system for an isochronous cyclotron is described. (W.H.K.)

45843 SOVIET ASSESSMENT OF SERPUKHOV. Logunov, Antoly Alexeevich; Yarba, Victor Alexandrovich (Inst. of High Energy Physics, Serpukhov, USSR). New Sci. Sci. J.; 51: No. 760, 128-30(15 Jul 1971).

The Soviet 70-GeV proton accelerator is the largest in the world. Results from its first three years of operation include the detection of anti-helium particles for the first time and the non-detection of any particles to support the quark theory. (auth) (UK)

45844 SUITABILITY OF TURBO MOLECULAR PUMPS FOR USE WITH A SMALL VAN DE GRAAFF ACCELERATOR. Broe, H.; Van Heugten, A. (Australian Atomic Energy Commission, Lucas Heights). Vacuum; 21: No. 1-2, 41-3(Jan-Feb 1971).

Simplicity, cleanliness, low maintenance and the performance of turbo-molecular pumps make them very suitable for use with a 3 MeV Van de Graaff accelerator. Experience in such an application at Lucas Heights is reported and the merits of the pump are compared with those of alternative types. (auth) (UK)

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45845 SHIELDED ENCLOSURE BUILT WITH RAILWAY LINES. Bonet-Maury, P. (Institut du Radium, Paris). Radioprotection; 6: No. 2, 143-7(1970). (In French).

Used railway lines can be utilized to construct an iron radioprotection shielding around large sources of ionizing radiations. Using this material, a biological shielding was constructed for a 20 MeV betatron, which appears to be satisfactory from both the technical and economic point of view. (auth) (France)

45846 CHECKING AND MONITORING SAFETY SYSTEM LOGIC CIRCUITS. Hartin, W. J. (Brookhaven National Lab., Upton, N. Y.); Goodman, L. J. Contract AT(30-1)-2740. Health Phys.; 21: No. 2, 309-15(Aug 1971).

A checking and monitoring section is described which was added to an existing accelerator safety system. The entire system uses integrated circuit logic in place of electromechanical relays. The basic safety system uses two independent parallel logic lines, either of which can stop accelerator operation if an error is detected. The monitor circuits continuously compare similar points in the two logic lines, and give warning if these points are not in agreement. The monitoring circuits can be readily tested by the checking section. Upon command this section tests each of the monitoring circuits in turn, and triggers an alarm if any circuit does not respond properly. The checking circuits are made to be self testing, so that initiation of the checking procedure is not possible if this section is not operating properly. The checking and monitoring sections make it virtually impossible for safety system circuit malfunctions to go unnoticed and thereby cause logically unsafe operation. (auth) (UK)

45847 NEW DIODE FOR THE PRODUCTION OF HIGH POWER RELATIVISTIC ELECTRON BEAMS. Friedman, M. (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instrum.; 42: No. 8, 1255-6(Aug 1971).

A new type of low impedance diode has been developed to produce pulsed relativistic electron beams. Using a multicathode system, the diode impedance was lowered to ~4 Ω. Currents of ~60 kA and voltages of ~250 kV have been obtained. (auth)

45848 PROTON CURRENT DURING A DECREASE OF THE EQUILIBRIUM PHASE ALONG A LINEAR ACCELERATOR. Vlasov, A. D. At. Energ. (USSR); 30: No. 5, 464-6(May 1971). (In Russian).

During the operation of a linear accelerator under stable and neutral conditions, an increase in the equilibrium phase from about 40° to nearly 90° results in proton currents from a few hundred mA to as much as 10 A. The effect on linear accelerator operation of an equilibrium phase of 85 to 90° at the beginning and gradually decreasing along the length of the accelerator is considered. It is mathematically demonstrated that reasonably small currents are thus achieved. (K.S.W.)

45849 ACCELERATION OF PROTONS TO ENERGIES GREATER THAN E_o IN AN ISOCHRONOUS CYCLOTRON. Sarkisyan, L. At. Energ. (USSR); 30: No. 5, 466-8(May 1971). (In Russian).

Non-linear effects play an important role in isochronous cyclotrons with three-dimensional variations of the magnetic field. A "cascade" isochronous cyclotron is proposed which would have the capability of accelerating protons to energies greater than E_o (the energy of resting particles). This cascade technique uses injection of the output of one cyclotron into the next cyclotron, thereby doubling the kinetic energy of the particle during each stage of the cascade. (K.S.W.)

45850 PREPARATION OF SUPPORTED, LARGE-AREA, UNIFORMLY THIN SILICON FILMS FOR PARTICLE-CHANNELING STUDIES. Meek, R. L.; Gibson, W. M.; Braun, R. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Nucl. Instrum. Methods; 94: No. 3, 435-42(1971).

A method for producing large-area, several-thousand-A thick silicon films supported by a frame of thicker material by selective electro-chemical etching is described. Preliminary results on use of the films for channeling studies are presented, especially as they relate to characterization of the film itself A number of experiments of interest and importance, some of which are presently in progress, are discussed. (auth)

45851 REGENERATION OF TITANIUM TRITIDE TARGETS BY THERMAL TREATMENT. Bibby, D. M.; Oldham, G.; Ware, A. R. (Loughborough Univ. of Tech., Eng.). Nucl. Instrum. Methods; 94: No. 3, 397-400(1971).

The possibility of redistributing the residual tritium in used titanium tritide targets by thermal treatment is investigated and found to be quite feasible. The increase in tritium content in the d + T reaction region of the target was shown by measuring the "surface" tritium activity before and after heat treatment. The improvement in neutron output from a treated target was measured. (auth)

45852 NOTE ON THE PRODUCTION OF INTENSE BEAMS OF NEGATIVE HEAVY IONS. Freeman, J. H.; Temple, W.; Chivers, D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 94: No. 3, 581-2(1971).

Some preliminary experiments on the use of a lithium-vapor charge-exchanger with an isotope-separator heavy-ion source to produce negative ions are described. High-intensity isotopically resolved beams of a range of elements and compound ions were readily obtained (≥200 μA Te^-; ≥50 μA Ni^-; ≥25 μA Fe^-; ≈1 μA U^-). (auth)

45853 OVERLOAD PROTECTION CIRCUIT FOR VAN DE GRAAFF ACCELERATOR DRIVE MOTORS. Lockwood, W. A.; Umbarger, C. J. (Univ. of Kansas, Lawrence). Nucl. Instrum. Methods; 94: No. 3, 583-4(1971).

A circuit is described which protects Van de Graaff accelerator drive motors against overloads. The circuit is fast-reacting, inexpensive, extremely sensitive, and installed externally to the accelerator. (auth)

45854 NEUTRAL ATOM COMPONENT OF HIGH FREQUENCY ION SOURCE BEAM. Bodizs, D.; Koltay, E.; Szalay, A. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instrum. Methods; 94: No. 3, 537-9(1971).

The intensity ratio of neutral atoms to charged ions (I^0/I^+) was investigated in the beam of a rf ion source as function of the extraction voltage and of the pressure in the hydrogen discharge. Neutral particles were detected by calorimetric and secondary-electron-emission methods. The effect of the neutral beam on the x-ray background of a 1-MV Van de Graaff generator was also demonstrated. (auth)

45855 MESON CHANNEL DESIGN AND PERFORMANCE FOR THE SREL SYNCHROCYCLOTRON. Funsten, H. O. (Coll. of William and Mary, Newport News, Va.). Nucl. Instrum. Methods; 94: No. 3, 443-51(1971).

A pion–muon channel is designed for internally generated mesons from the NASA Space Radiation Effects Laboratory 600-MeV synchrocyclotron. The channel, similar to those at CERN and Chicago, consists of three sections: a main section containing 24 identical 11'' bore quadrupole magnets, an input matching section consisting of a quadrupole doublet for matching to the meson emittance from the cyclotron, and an output bending magnet. Computer programs using quadrupole transfer matrices including linear magnetic fringe field effects are used to optimize the meson flux. The main-section quadrupoles have terraced pole tips and achieve a gradient of 2.4 kG/in. Movable channel mounting is incorporated with pillared shielding to facilitate reorientation of the channel with respect to the cyclotron to change the mean pion momentum entering the channel. Seven hundred forty stopped μ^- per gram-sec and 1.500 stopped π^- per gram-sec were observed in a 6″ × 6″ target. (auth)

45856 PROCESS FOR ACCELERATION OF MULTIPLY CHARGED IONS OF HEAVY ELEMENTS. Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Kol'ga, V. V. (to Joint Inst. for Nuclear Research). Russian Patent 240,884. 1 Apr 1969. Filed 16 Aug 1967. (In Russian).

The procedure is based on acceleration in cascade. In order to reduce the size of the accelerator and to obtain energies above the Coulomb energy for the elements from krypton to uranium, after a prior acceleration of the ions by a strong-focusing cyclic accelerator, the ions are extracted from the accelerator and then reintroduced into the median plane of the cyclic accelerator at the point of the supercharged target and the multiply charged ions obtained are accelerated in the same accelerator to a final energy of 7 to 10 MeV per nucleon. (E.J.H.)

45857 MICA TARGETS WITH NEARLY A 4pi GEOMETRY FOR FISSION STUDIES. Boos, A. H.; Brandt, R.; Starke, K. (Univ., Marburg, Ger.). pp VIII.9-14 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

A target system which allows the study of ternary fission of heavy elements with different bombarding particles approaching the 4π geometry as close as possible is studied. Narrow holes are produced in mica by etching fission tracks. These holes are

filled with a uranium compound. After irradiation the newly formed fission fragments can be made visible as fine tracks emerging from the original holes. The present status of this method is given. (auth) (France)

45858 USE OF LOW ENERGY ACCELERATORS. Proceedings of the Symposium, London, 27–29 May 1970. Jiggins, A. H.; Demetsopoullos, I. C. (eds.). Nucl. Instrum. Methods; 92: No. 4, 445-636(1971). (CONF-700563).

Separate abstracts are prepared for the 26 papers included. (C.E.S.)

For abstracts of individual papers see: 44353, 44658–44660, 44677, 44817, 44818, 45302, 45569–45571, 45859–45866, 45884–45888, 45943, and 46075.

45859 HARWELL 500 kV COCKCROFT–WALTON ACCELERATOR AND ITS USE AS A GENERAL RESEARCH FACILITY. Goode, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 92: No. 4, 447-53(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A 500-kV Cockcroft–Walton accelerator is described which can be operated with either a Harwell sputtering ion source or an rf ion source. By using the sputtering source, ions up to mass 209 were accelerated with beam currents ranging from 1 to 80 μA while the rf source provides larger beams (typically 300 μA) of certain light ions. The heavy-ion beams used mainly for ion implantation studies, range and energy-loss measurements in silicon crystals, and the generation of characteristic x rays by heavy-particle irradiation. The ion-implantation studies included the doping of silicon crystals with ^{11}B and ^{31}P for device manufacture and to investigate the profiles of the electrically active carriers, the doping of compound semiconductors for electroluminescence studies, and bombardment of semiconductors to investigate radiation damage. Provision is made in the target stage of the implantation chamber for heating and cooling the specimens and orienting crystal axes with respect to the beam direction. The rf ion source is used mainly to provide large beams of deuterons for neutron production. Neutrons generated by the D–T reaction were used in activation analysis of flowing systems, in the development of a neutron shielding window for use in neutron therapy, and for the irradiation of phantoms and human subjects for radiobiological research. Typical experimental results taken from the implantation work, range measurements, characteristic x-ray studies, and neutron activation experiments are shown in order to illustrate the wide application of the accelerator. Its usefulness indicated the need for a lower energy machine to complement the facility. An 80-kV accelerator is now under construction. This machine, fitted with a Harwell sputtering ion source, is being sited so that it can be coupled with the 500-kV machine to provide two beams simultaneously at certain target positions. (auth)

45860 USE OF LOW-ENERGY ACCELERATORS FOR ION IMPLANTATION. Cracknell, P. J.; Gettings, M.; Stephens, K. G. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 92: No. 4, 465-9(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The ion implantation research program in the Electronic and Electrical Engineering Department at the University of Surrey is discussed together with the manner in which this program has influenced the design and specifications of the machines being built. Two machines are described: a 600-keV heavy-ion accelerator with an ultrahigh-vacuum target-chamber assembly and a 2-MeV Van de Graaff used for charged-particle scattering experiments that allow impurity site locations and lattice damage to be studied. (auth)

45861 PERFORMANCE OF A SPUTTER ION SOURCE AND ITS APPLICATION FOR IMPLANTED ION PROFILE EXPERIMENTS. Brown, G.; Renton, M. L. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 92: No. 4, 477-80(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The 180-keV ion accelerator of the University of Surrey is described. This machine, which uses a sputter ion source of the Hill–Nelson design, was shown to be capable of providing beam currents of up to 50 μA of gas ions and 10 μA of metallic ions. Experiments for which this implantation facility was designed are briefly described. (auth)

45862 MICROANALYSIS BY THE DIRECT OBSERVATION OF NUCLEAR REACTIONS USING A 2 MeV VAN DE GRAAFF. Amsel, G.; Nadai, J. P.; d'Artemare, E.; (and others) (Ecole Normale Superieure, Paris). Nucl. Instrum. Methods; 92: No. 4, 481-98(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The principles of nuclear microanalysis by the direct observation of the charged particles emitted from nuclear reactions with light nuclei are described. This method allows the determination, in short times, of very small quantities of nuclei like ^{16}O, ^{18}O, ^{14}N, ^{19}F, etc., near the surface of samples. Typical sensitivities are of the order of 10^{14} atom/cm^2. Concentration profiles as a function of depth may be directly measured with submicron resolution. The technical details of a facility comprising a 2-MeV Van de Graaff accelerator are given. Problems related to particle detection and data recording are discussed. The various scattering chambers, which allow most of the measurements to be carried out automatically with digital control, are described. Applications to various fields in solid state physics, metallurgy, and electrochemistry are presented. (auth)

45863 OPTIMAL GENERATION OF 14 MeV NEUTRONS BY MEANS OF TRITIATED TITANIUM TARGETS. Guillaume, M.; Delfiore, G.; Weber, G.; Cuypers, M. (Univ., Liege). Nucl. Instrum. Methods; 92: No. 4, 571-6(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A great number of systematic manufacturing tests on titanium targets followed by the study of their behavior under deuteron beams proved that the main factor determining the parameters of a tritiated target is the purity of the titanium layer. An interpretation of the mechanism of the decrease of the neutron output is given. The optimal conditions of the use of tritiated targets are deduced. (auth)

45864 EXTERNAL PULSING OF AN ACCELERATOR. Cooper, P. N.; Doukas, L. (Univ. of Aston, Birmingham, Eng.). Nucl. Instrum. Methods; 92: No. 4, 581-4(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A SAMES 150-keV accelerator was adapted to produce a square beam-current waveform for reactor physics transfer-function studies. Trigger pulses are conveyed to the high-voltage terminal by an optical link using semiconductor devices, and the beam is pulsed by switching the ion source rf. The operating frequency ranges from a few Hz up to a few kHz. (auth)

45865 DESIGN STUDY OF A LOW-ENERGY AND HIGH-POWER ACCELERATOR. Hourst, J. B.; Roche, M. (Centre d'Etudes Nucleaires, Is-sur-Tille, France). Nucl. Instrum. Methods; 92: No. 4, 589-94(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

A low-energy (150 to 250 kV), but very powerful electrostatic accelerator is described. Its purpose is to yield very intense (3×10^{12} n cm^{-2} s^{-1}) neutron flux (14 MeV). These neutron yields are attained thanks to the original target holders that are presented here. (auth)

45866 SPACE RADIATION SIMULATION USING A LOW-ENERGY ACCELERATOR. Meulenberg, A. (Communications Satellite Corp., Clarksburg, Md.). Nucl. Instrum. Methods; 92: No. 4, 621-3(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The COMSAT Labs space radiation simulation facility and its uses are briefly described. The facility consists of an ultraviolet solar simulator, capable of providing an output from 1 to 30 solar constants, and a low-energy particle accelerator. The accelerator is capable of providing a beam of protons and/or electrons ranging in energy from 100 eV to 150 keV. The facility is being utilized to investigate particulate, ultraviolet, and synergistic radiation effects in silicon and CdS solar cells, cover slides, anti-reflective coatings, adhesives, and thermal control coatings. (auth)

45867 TRENDS IN THE UNITED STATES FOR THE ACCELERATION OF HEAVY IONS. Livingston, Robert S.; Martin, John A. (Oak Ridge National Lab., Tenn.). Particle Accel.; 2: No. 3, 189-202(Jul 1971).

The performance of US accelerators for heavy ions is compared. The review includes existing accelerators, those under construction, and proposed accelerators. The desirable characteristics for a forefront heavy ion accelerator are listed. A description of the super-HILAC conversion serves to highlight the discussion of progress in the United States. As an example of the possibilities and limitations of present-day isochronous cyclotrons, the heavy ion acceleration capabilities and use of the Oak Ridge Isochronous Cyclotron are discussed. The possibilities of new concepts including superconducting linear accelerators and supervoltage

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tandems are reviewed briefly. The performance characteristics of major existing and proposed European accelerators are compared. (auth)

45868 IMPROVING THE ENERGY RESOLUTION AND DUTY FACTOR OF ISOCHRONOUS CYCLOTRONS. Gordon, M. M. (Michigan State Univ., East Lansing). Particle Accel.; 2: No. 3, 203-9(Jul 1971).

A separated turn isochronous cyclotron can produce beams having a precise energy resolution together with a substantial duty factor if the effective voltage wave form is "flat-topped". Optimum flat-topping results are presented for five different harmonic combinations: n = 1 and 2; n = 1, 2, and 3; n = 1, 2, 3, and 4; n = 1 and 3; n = 1, 3, and 5. For a given energy resolution, the improvement in duty factor with each added harmonic is quite impressive. The success of this technique is limited by certain practical problems which are examined. (auth)

45869 EXTRACTION OF SLOW MUONS GENERATED NEAR TARGET. Tanabe, Kosai (Yale Univ., New, Haven). Contract AT(30-1)-2726. Particle Accel.; 2: No. 3, 211-25(Jul 1971). (YALE-2726-588).

The behavior of the slow muons generated from the pion decay near the primary target is investigated in great detail. The calculations are based on the recently available pion production cross sections, which include measurements at large production angles and low momenta. The characteristics of the available muon flux are derived by evaluating the intensity distribution in momentum space, muon polarization, and integrated flux intensity for various parameters of an intentionally misaligned channel. Applying the above results we investigate possible methods of transport. Evaluations of the beam intensity and average polarization are carried out for some simple systems. The result implies that the expected output intensity is comparable to that from an elaborate stopped muon channel of the standard type. (auth)

45870 EFFECT OF RANDOM FIELD ERRORS WITH APPLICATION TO SLOW EXTRACTION. Month, M.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 3, 227-34(Jul 1971).

The effects due to magnetic field perturbations caused by random errors in the coil positions in the magnets of a high-field superconducting accelerator are investigated. An error in the position of a particular current block of a bending magnet with a cosine current distribution will introduce nonlinear sextupole and higher-pole terms in the median plane magnetic field. These nonlinear terms may produce serious effects by exciting nearby nonlinear resonances, and, in particular, they may seriously affect a slow extraction system that uses sextupoles to excite a nearby one-third resonance. The nonlinear fields due to random errors of the current blocks are estimated and the resulting nonlinear harmonics around the accelerator are found to be comparable to the nonlinear harmonics introduced by the slow extraction sextupoles. A method for correcting the field effects due to the random errors in the current blocks is investigated. This correcting method uses additional correcting sextupoles and octupoles, and was found to be able to correct for the effects of the random field errors in the slow extraction system. (auth)

45871 ELECTROPLATING OF PROTON LINEAR ACCELERATOR TANKS. Tanaka, J.; Nishikawa, T.; Baba, H. (Tokyo Univ.). Particle Accel.; 2: No. 3, 235-41(Jul 1971).

An electroplating method was developed for fabricating proton linear accelerator tanks. A uniform, smooth and thick copper layer was obtained by using a copper bath with an organic brightening agent and improving the plating techniques. The mechanical, electrical and vacuum properties of accelerator tanks are much improved by the newly developed method. Measured Q values as large as 90% of the calculated values are obtained. (auth)

45872 STUDY OF INVARIANTS OF EQUATIONS OF MOTION IN CALCULATIONS OF ABERRATION COEFFICIENTS. Sivkov, Yu. P. (Research Inst. of Electrophysical Instrumentation, Leningrad). Particle Accel.; 2: No. 3, 243-9(Jul 1971).

Aberration coefficients, i.e., the coefficients in the expansion of the equations for the trajectories of charged particles $q_i = q_i(q_{10}, p_{10}, \cdots q_{k0}, p_{k0} \cdots q_{n0}, p_{n0}, s)$ $p_i = p_i(q_{10}, p_{10}, \cdots q_{k0}, p_{k0} \cdots q_{n0}, p_{n0}, s)$ in powers of the initial conditions q_{k0}, p_{k0} are studied. It is shown that, owing to the invariants of the equations of dynamics, these coefficients are related to each other by certain identities, for whose construction a method is given. In particular, a system of identities relating the second and third order aberration coefficients is constructed for a stationary field possessing one or two planes of symmetry. (auth)

45873 SOURCE FUNCTIONS AND TRANSPORT LOSSES FOR A 28-GeV EXTERNAL PROTON BEAM. Bennett, G. W.; Levine, G. S.; Moore, W. H. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 3, 251-6(Jul 1971).

Dose and flux measurements along the axis of a practical external beam transport system are reported for various target configurations. Source functions are derived and normal transport beam losses are found by extrapolation. In addition, inside the shield, we have measured the ratio of dose measured by β and γ sensitive film to the "neutron" dose measured by NTA film, as well as the ratio of total dose to secondary flux density using ^{11}C activation. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 45593, 45851, and 45865.

45874 PRODUCTION OF MEDIUM-ENERGY NEUTRONS FROM PROTON BOMBARDMENT OF LIGHT ELEMENTS. Jungerman, J. A.; Brady, F. P.; Knox, W. J.; (and others) (Univ. of California, Davis). Nucl. Instrum. Methods; 94: No. 3, 421-7(1971).

Cross sections for neutron production from targets of ^{2}H, ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C, and ^{27}Al were measured at 0° for incident proton energies of approximately 30, 40, and 50 MeV. For production of a monoenergetic neutron beam in this energy region ^{7}Li is the best practical target. ^{12}C has a low neutron production cross section and is particularly useful for proton-beam collimation. (auth)

45875 MICROGUIDES FOR NEUTRONS. Marx, D. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Nucl. Instrum. Methods; 94: No. 3, 533-6(1971).

Microguides for thermal and subthermal neutrons were produced by using a refined evaporation technique to get sandwiches of alternate nickel and aluminum layers. So far 100 double layers with total thickness 0.037 mm and radius of curvature 15 cm have been made. Neutrons of a wavelength of 2 Å and more were deflected up to 4 degrees (up to 25 times the critical angle of total reflection), the radius of curvature of the trajectory of the neutrons being 15 cm. A reflectivity of ≧97 percent was observed. The possibility of focusing ("neutron lens") or polarizing neutron beams with this device is discussed. (auth)

45876 EIGENVALUE PROBLEM OF A TRANSPORT EQUATION. Ukai, Seiji (Kyoto Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 24, 1-11 (Sep 1969). (In Japanese).

The spectrum of the neutron transport operator for a finite-size homogeneous moderator is discussed. The transport equation to be solved is $(\partial/\partial t)\,N = BN$, $BN \equiv -\nu \cdot \nabla N(\gamma,\nu,t) - V\Sigma t(V)N(\gamma,\nu,t) + \int_v \Sigma s(\nu' \rightarrow \nu)N(\gamma,\nu',t)d\nu'$ where D is a region occupied by moderator, γ is a position vector, ν is neutron velocity, N is neutron density distribution, $V = |\nu|$, Σ_t is total cross-section and Σ_s is scattering cross-section. B is named a neutron transport operator. The equation was solved by a Laplace transform method. The theory of the function of complex variables was applied to investigate the character of the solution. Spectra were classified according to the properties of singularity. The Hill–Yoshida theorem was applied to study the existence and uniqueness of the solution. The spectra of B were given for gas, liquid and solid moderators. Eigenvalues were also discussed. (Japan)

45877 EMPIRICAL FORMULA FOR NEUTRON DIFFUSION SYSTEMS ACCORDING TO THE METHOD OF DESIGN OF EXPERIMENTS. Hoshino, Tsutomu (Kyoto Univ., Uji, Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 26, 1-10(Dec 1969). (In Japanese).

The method of design of experiments was used to obtain a diffusion equation, the equation being considered as a black box, and an empirical formula representing the relation between input and output was obtained by many experiment runs. Design of experiments is a method to obtain efficiently information concerning the unknown relation between sources (factors) and results (observed values). The factor effect which influences observed values consists of main effect and interaction. Among the interactions, secondary and higher-order interactions are usually neglected in comparison with the main effect and primary interaction. First of all, the factors which uniquely determine observed values are assumed. Main effect and interaction are assigned to the row of an orthogonal array. Then the combination of the level of each factor is taken from the column of the array, trial is carried out, and observed data are obtained. The observed values are treated by variance analysis and regression analysis. In the present paper, the value to be obtained is expanded in a quadratic equation of M factors. Regression coefficients should be determined to find an empirical formula. As an example, a diffusion equation for two group–two region was analysed. Macroscopic cross-section and regional volume were taken as factors, and the criticality coefficient was the output. The numerical calculation with 14 factors was carried out, and it was found that this method is useful. (Japan)

45878 PROPAGATION OF NEUTRON WAVES IN C-U SYSTEM. Matsumoto, Takaaki (Kyoto Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 26, 11-20(Dec 1969). (In Japanese).

Experiments were performed on the propagation of neutron waves in an inhomogeneous, multiplicative system. The systems employed for the experiment were C–U 1 with nine layers of natural uranium, each 1 mm thick, and C–U 5 with four layers of natural U, each 5 mm thick. For comparison, experiments were also performed with a C system. The neutron beam was modulated into harmonic waves, and was detected with a BF_3 counter after propagating some distance in the system. The measurement was made for various angular frequencies up to 8×10^3 rad/sec and the distance × from 25 cm to 75 cm. For x < 50 cm, the neutron distribution was still transient type. It was shown that this was due to the thermal neutron source employed in the experiment. For x > 50 cm, where the asymptotic distribution was realized, the dispersion relation, which was theoretically derived, was applied for analysis. The effect of inhomogeneity was recognized. (Japan)

45879 SPATIAL DISTRIBUTION NEAR BOUNDARY IN NEUTRON WAVE TRANSPORT PROBLEM. Tezuka, Masaji (Osaka Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 21, 16-33(Mar 1969). (In Japanese).

The neutron flux in three square pillar systems was obtained from the transport equation. The following assumptions were considered in the analysis: when an oscillating isotropic source exists, the neutron flux $f(E\vec{r}^{0}\Omega t)$ is written in a form $f = \bar{f}(E\vec{r}^{0}\Omega;\omega)\,e^{i\omega t}$; scattering is isotropic, since the thermal region is considered; the neutron flux in side directions is approximated by the diffusion theory; and a separated kernel is used for the scattering kernel concerning energy. With these assumptions and boundary conditions, the solution of the Boltzmann equation was obtained for the systems of an infinite square pillar, a semi-infinite square pillar having a neutron source at infinity (Milne's problem), and a semi-infinite square pillar having a neutron source at x = 0 (Albedo's problem). When energy is constant, the solution is simplified; and the spatial distribution could be obtained. The analysis showed that the asymptotic solution gives the basic mode of neutrons which had one or more collisions in the systems, while the continuous solution gives the neutron flux which penetrated from the source without any collision. Neutrons from the region x > 0 in an infinite medium made a collision at x < 0, and came back to x > 0 without collision. On the other hand, this effect could not be seen in a semi-infinite system. (Japan)

45880 CALCULATION OF NEUTRON AGE AND NEUTRON FLUX BY DIRECT OPERATIONAL METHOD. Yamamura, Yasumichi (Osaka Univ.). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 23, 1-23(Jun 1969). (In Japanese).

The formal solution for neutron age and neutron flux was obtained by the use of a direct operational method. A fundamental formula of neutron age was obtained by a stochastic method. A fundamental equation of neutron distribution when neutron sources $\delta(u-u_0)$ were distributed uniformly in an infinite homogeneous system was given as follows: $gb(u, u_0) = \int_0^u \Sigma(u' \rightarrow u)\, gb(u', u_0)du' + \delta(u-u_0)$, where $\Sigma(u' \rightarrow u)$ is transition probability and $gb(u, u_0)$ is neutron collision density. Σ is the sum of the terms due to elastic scattering, inelastic scattering and (n, 2n) reactions. The calculation formulas to determine neutron distribution and neutron age include cross-sections as a function of energy, and have such features that the fine structure of the cross-section in a fast region is incorporated into calculated result. The numerical calculation for neutron flux and neutron age in light water was carried out with the Osaka University NEAC 2200. The result showed good agreement of the calculated values with the experimental values. (Japan)

45881 FAST NEUTRON PULSE PROPAGATION IN IRON. Napolitano, Carl Mario. Gainesville, Fla.; Univ. of Florida (1970). 174p. University Microfilms Order No. 71-13,442. Thesis.

An experimental and theoretical study of the space–time–energy behavior of a source of neutrons propagating, moderating, and dispersing through a non-multiplying medium is presented. Fast-neutron pulse-propagation studies in an 81 cm × 81 cm × 152 cm iron assembly were made using ~1-nsec wide pulses of nearly monoenergetic neutrons. Neutron–gamma discrimination, time-of-flight, and two parameter data acquisition were employed to measure a proton-recoil detector time response at various positions along an assembly axis. The amplitude and phase of the Fourier-transformed detector response were least-squares fitted to give the real and imaginary parts of the complex inverse re-

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laxation length. Preliminary experimental results for 1.25 MeV and 850 keV showed a sharp disagreement with monoenergetic theoretical predictions. The discrepancies were attributed to the structure of the cross sections at the energies considered, the time-dependent spectral shifts due to elastic scattering, and the deep penetrations of first-flight neutrons at energies corresponding to minima in the cross-section curve. Measurements using pulsed neutrons with source energies of 2.2 ± 0.05 MeV and 2.5 ± 0.06 MeV were made. Slowing-down measurements, made by using a pulse-height-spectrum unfolding technique, yielded a moderation function for elastic scattering in iron. It was concluded that the agreement between the theory and the quasi-monoenergetic experiment is quite reasonable, the strong cross section structure of iron greatly increased the difficulty of interpretation, and more detailed studies of the moderation process with high-resolution detectors are necessary. (TSS) (Diss. Abstr. Int., B)

45882 STUDY OF RESONANCE ABSORPTION NEAR SODIUM RESONANCE AT 2.85 keV. Kamei, Takanobu; Mizuta, Hiroshi (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: No. 6, 333-41(Jun 1971).

A method for calculating the neutron flux in a heterogeneous system, utilizing a combination of two different energy meshes—coarse and fine—is presented. The method was programmed in a computer code EXRE-2. This method is particularly suitable for computations of fast-reactor spectra that carry both broad and fine undulations. Pointwise cross-section curves are prepared by superposition of the Breit–Wigner single level formula. In the energy region where the resonance is not resolved, a random sampling procedure is used for the derivation of resonance parameters. Group-averaged resonance capture and fission cross sections and the temperature dependence of these quantities are computed for a typical fast reactor. An examination is made of the applicability of the conventional narrow resonance (NR) approximation applied over a rather wide energy group, and the heterogeneity effect on the resonance cross sections, near the sodium resonance at 2.85 keV, is considered. The error due to the NR approximation was found to be fairly large in the case of the heterogeneous model, but negligible in the homogeneous. The heterogeneity effect was also negligible except for the Doppler cross sections in the immediate neighborhood of 2.85 keV. (auth)

45883 WEIGHTING AND BIASING OF A MONTE CARLO CALCULATION FOR VERY DEEP PENETRATION OF RADIATION. Lanore, Jeanne-Marie (Nuclear Research Center, Fontenay-aux-Roses, France). Nucl. Sci. Eng.; 45: No. 1, 66-72(Jul 1971).

With the solution of the adjoint to the transport equation as a basis, the development of a weighting and biasing system permitting me to obtain, by means of the Monte Carlo method, a constant variance in every point of the phase space is described; this constant variance is strict in a particular case and nearly strict in the general case. Neutron spectra at a very great distance from the source are thus derived with good precision. (auth)

45884 NEUTRON POLARIZATION STUDIES WITH LOW-ENERGY ACCELERATORS. Galloway, R. B. (Univ. of Edinburgh). Nucl. Instrum. Methods; 92: No. 4, 537-46(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The role of low-energy accelerators in fast-neutron polarization studies is assessed in the light of a review of the value of information on polarization, the techniques available for the measurement of the polarization of a fast-neutron beam, and the available data on neutron polarization resulting from elastic scattering and from nuclear reactions. Data on the principal neutron-producing reactions is summarized for incident-particle energies up to 10 MeV. (131 references) (auth)

45885 SOME TECHNICAL PROBLEMS IN ACTIVATION ANALYSIS USING A 14 MeV NEUTRON GENERATOR. Reimers, P.; Santner, E. (Materialpruefung und Strahlenschutz, Berlin). Nucl. Instrum. Methods; 92: No. 4, 577-9(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Cu plates were used to study the inhomogeneous neutron fields produced by a neutron generator. To improve spatial and particularly temporal constancy of the flux density distribution, a method was developed for fanning out the beam over the entire target. A greater fwhm of flux density distribution and a shallower slope in the direction of the beam axis were obtained. Thermal stresses, the main cause of depletion in tritium targets, were ameliorated. (R.W.R.)

45886 OPTIMIZATION AND PERFORMANCE OF A NEUTRON HOWITZER. Cox, A. J.; Francois, P. E. (Univ. of Aston, Birmingham, Eng.). Nucl. Instrum. Methods; 92: No. 4, 585-8(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The design of moderating systems to give beams of thermal neutrons from isotope or accelerator fast-neutron sources is studied. Suggestions are made about the best design of such "howitzers" when constructed of paraffin wax. The spatial distribution of neutrons from such a system was studied, and investigations of the spectrum were made by foil activation and by time-of-flight methods. The latter technique is described in detail. An example of neutron radiography using the neutron beam is given. (auth)

45887 USE OF A 10^{11} n/sec NEUTRON GENERATOR FOR NEUTRON RADIOGRAPHY. Spowart, A. R. (United Kingdom Atomic Energy Authority, Thurso, Eng.). Nucl. Instrum. Methods; 92: No. 4, 613-17(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

Although the experiment is still at an early stage, it is already clear that the unit can produce useful neutron radiographs of a variety of specimens when exposure times varying from 5 to 30 min depending on exposure conditions. (Exposure times used were 5 min for the direct technique and 30 min for transfer exposures.) The tube output is being further increased, and an enriched uranium booster is being installed, to allow the collimation of the beam to be improved while keeping the specimen exposure times constant. The enrichment of the boosters is to be 75% ^{235}U. (auth)

45888 NEUTRON GENERATOR IN UNDERGRADUATE TEACHING. Oldham, G.; Poxon, D. W.; Ware, A. R. (Loughborough Univ. of Tech., Eng.). Nucl. Instrum. Methods; 92: No. 4, 619-20(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The fast-neutron generator has proved to be an invaluable aid in undergraduate teaching. It may be used for the preparation of shortlived isotopes or for physical experiments, such as measurement of half life, examination of gamma spectra, etc; in addition, this can be coupled with chemical manipulation by carrying out Szilard–Chalmers reactions. Nuclear reactions may be investigated; and activation analyses, such as the determination of fluorine in organic fluorocompounds, carried out. Radiation damage can be quickly demonstrated by a new chromatographic technique. (auth)

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Refer also to abstracts 44658, 44742, 45874, 45884, 45922, 46021, 46025, and 46122.

45889 ANALYSIS OF D(p,2p)n REACTION BY THE FADDEEV EQUATION WITH THE OFF-SHELL TWO-BODY AMPLITUDES. I. Oryu, Shinsho (Science Univ. of Tokyo). Progr. Theor. Phys. (Kyoto); 45: No. 2, 386-402(Feb 1971).

The Kuckes–Wilson–Cooper theory, which is the semiexperimental impulse approximation, is generalized by the use of the three-body Faddeev equation. The low-energy deuteron break-up reaction by protons is calculated by this formalism. The off-shell amplitudes of the nucleon–nucleon separable potential are used for the calculation of Faddeev amplitudes. The results are compared with the experimental results for the incident energies 38 MeV to 50 MeV. In the reaction D(p,2p)n, it is found that the final-state interactions as well as the quasi-free scattering are significant in low-energy regions and that the off-shell amplitudes play an important role in the high-momentum component of nucleon–nucleon interactions. (auth)

45890 MEASUREMENT OF PROTON POLARIZATION IN THE d–d REACTION. Stricker, A.; Baumgartner, E.; Ellgehausen, D.; Gleyvod, R.; Huber, P. Helv. Phys. Acta; 44: No. 2, 279-92(1 Apr 1971). (In German).

The polarization of protons from the D(d,p)T reaction was measured at four laboratory angles (θ_{Lab} = 27°, 32°, 45°, 63°) for a mean deuteron energy of 650 keV. A thin D_2-gas target was used; scattering from helium served as the polarization analyzer. The maximum polarization is found to be −11%. The angular dependence was fitted to a sum over associated Legendre functions. It is shown that only the first term is significantly different from zero. (auth)

45891 REACTION ^{3}He(d,p)^{4}He WITH POLARIZED AND UNPOLARIZED TARGETS AND POLARIZED DEUTERON BEAMS OF 430 keV. Leemann, Ch.; Buergisser, H.; Huber, P.; (and others) (Univ., Basel). Helv. Phys. Acta; 44: No. 2, 141-59 (1 Apr 1971). (In German).

The sensitivities of the ^{3}He(d,p)^{4}He reaction to deuteron polarization and some selected combinations of ^{3}He and deuteron polarization were measured at E_d = 430 keV. In addition to the reaction matrix element $R_1 = (2\ ^1/_2\ ^3/_2{}^+ |R|\ 0\ ^3/_2\ ^3/_2{}^+)$ giving the main contribution to cross section and polarization sensitivities, p- and d-wave admixtures of the order of a few percent relative to R_1 are found. Real parts of the matrix elements, which were calculated from the experimental results, and the influence of p- and d-waves on the analyzing power of the reaction are discussed. (auth)

45892 NEUTRON–PROTON SCATTERING CROSS SECTION AT A FEW ELECTRON VOLTS AND CHARGE INDEPENDENCE. Houk, Theodore L. (Harvard Univ., Cambridge, Mass.). Phys. Rev., C; 3: No. 5, 1886-1903(May 1971).

The neutron-proton total cross section was measured in hydrogen gas at 0°C between 0.3- and 400-eV lab energy to help improve the data for computing the n-p singlet effective range r_s. To obtain the free n-p scattering cross section at "zero" energy, the capture-cross-section, effective-range, and molecular-binding contributions were subtracted from the total cross section. The asymptotic "MTV" theory of molecular binding due to Messiah was used, which limits the final analysis to the range 6.02 to 329 eV. From these data 20.436 ± 0.023 b was obtained for the free n-p scattering cross section. Using this number, the coherent-scattering-length measurements by Koester, a model due to Lomon and Feshbach for the triplet and singlet shape parameters, and the n-p cross section in the MeV range due to Engelke et al., r_s = 2.56 ± 0.05 F, 0.09 F higher than the former value was obtained. Adopting an energy scale due to Davis and Barschall for the higher-energy data raises r_s to 2.74 F, which is in close agreement with the value 2.70 F predicted by the charge-independence hypothesis. A measurement of the neutron-carbon cross section, formerly related to this problem, is also discussed. (auth)

45893 QUASIELASTIC ELECTRON SCATTERING FROM ^{3}He AND ^{3}H. Lehman, D. R. (National Bureau of Standards, Washington, D. C.). Phys. Rev., C; 3: No. 5, 1827-40(May 1971).

Quasielastic electron scattering from ^{3}He and ^{3}H is investigated with a model in which the two-nucleon interaction is described by a separable potential. Cross sections are given in the impulse approximation for the ejected proton and scattered electron detected in coincidence, and for detection of only the scattered electron. Both two- and three-body breakup of ^{3}He and ^{3}H are considered, with final-state interactions between the spectator nucleons included in three-body breakup. Good agreement is obtained with all the electrodisintegration data, except the ^{3}He coincidence data, for wave functions derived from separable potentials which reproduce the s-wave two-nucleon phase shifts at low and medium energies. Rescattering corrections between the spectator particles are found to be important in calculating three-body disintegration. The need for more refined and reliable coincidence data is reaffirmed. (auth)

45894 FAST-NEUTRON TOTAL CROSS SECTION OF DEUTERIUM. Davis, J. C.; Barschall, H. H. (Univ. of Wisconsin, Madison). Phys. Rev., C; 3: No. 5, 1798-1803(May 1971).

The neutron total cross section of deuterium has been determined with 1–2% accuracy at 27 energies between 1.5 and 27.5 MeV in order to investigate a 5% discrepancy in earlier measurements. The hydrogen total cross section was measured concurrently as a check on the accuracy of the method. The deuterium results agree with earlier Los Alamos data below 4 MeV and with Hanford data between 4 and 13 MeV, but disagree with these earlier measurements at other energies. (auth)

45895 d-^{4}He ELASTIC SCATTERING AT 12.000 MeV. Jett, J. H.; Detch, J. L. Jr.; Jarmie, Nelson (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 3: No. 5, 1769-70(May 1971).

Accurate cross-section measurements are presented for d-^{4}He elastic scattering at 12.000 MeV. (auth)

45896 DYNAMICAL ANALYSIS OF THE NUCLEAR REACTIONS ^{3}He(d,p)^{4}He AND ^{3}H(d,n)^{4}He. I. TWO-BODY STATES. De Facio, B. (Univ. of Missouri, Columbia); Umerjee, R. K. Nucl. Phys.; A169: No. 2, 257-74(1971).

Some general expressions for the two-body states of the two stable channels of the five-nucleon systems are presented. The concept of broken symmetries is applied to the polarization, the asymmetry and the vector analyzing powers of the incident deuteron and mass A = 3 particle to extract information on the reaction mechanism by inspection. (auth)

45897 DILATATIONAL OSCILLATIONS OF CLOSED-SHELL NUCLEI. Wong, S. K. M.; Saunier, G.; Rouben, B. (Univ. of Montreal). Nucl. Phys.; A169: No. 2, 294-304(1971).

The $J^\pi = 0^+$ breathing-mode energies were calculated for ^{4}He, ^{16}O, ^{40}Ca, ^{90}Zr, ^{120}Sn and ^{208}Pb (taken as closed-shell nuclei) within the framework of the self-consistent constrained Hartree–Fock method and the adiabatic approximation. Use was made of an effective semi-realistic interaction of Saunier and Pearson without any adjustable parameters. The breathing-mode energy E_{BM} for ^{4}He agrees well with experiment, and for heavy nuclei the quantity $E_{BM} A^{1/3}$ is constant, following very closely the prediction of the liquid-drop model. The inelastic electron-scattering form factor for ^{4}He was calculated and compared with experiment. (auth)

45898 HIGH ENERGY PHOTONUCLEAR EXPERIMENTS USING BEAM HARDENING. Thies, H. H.; Thomas, B. W.; Simmonds, P. E.; Crawford, D. M.; Bottcher, K. (Univ. of Western Australia, Nedlands). Nucl. Instrum. Methods; 94: No. 3, 551-55(1971).

The effect of beam hardening in high-energy photon-difference-type photonuclear experiments is calculated. With the gamma intensities available from linear accelerators an order of magnitude improvement in the accuracy of derived cross sections may be approached. Practical considerations are discussed and demonstrated by a sample numerical calculation. (auth)

45899 MEASUREMENTS OF SIX LIGHT MASSES. Smith, Lincoln G. (Princeton Univ., N. J.). Phys. Rev., C; 4: No. 1, 22-31(Jul 1971).

The mass differences of 16 doublets involving the six atoms H, D, ^{14}N, ^{16}O, ^{35}Cl, and ^{37}Cl were measured with a new rf mass spectrometer with considerably greater precision than was attainable with the mass synchrometer. By least-squares adjustment, best values of the mass excesses of these six atoms were determined for which the estimated errors are materially less than for previously published values. (auth)

45900 ACCURATE MEASUREMENTS OF THE NUCLEAR PROCESSES T(p,p)T, T(p,^{3}He)n, T(p,d)D, AND T($\vec{p}$,$\vec{p}$)T FROM 13 TO 20 MeV. Detch, J. L. Jr.; Hutson, R. L.; Jarmie, Nelson; Jett, J. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 52-64(Jul 1971).

Differential cross sections were measured with absolute accuracies of about 1.0% and relative accuracies of about 0.7% by using a tritium gas target with thin foil windows and a silicon surface-barrier detector telescope in conjunction with an on-line computer for mass identification and data handling. The angular scattering distributions for T(p,p)T, T(p,d)D, and T(p,^{3}He)n, and the proton asymmetries of T($\vec{p}$,$\vec{p}$)T were measured at a proton laboratory energy of 13.600 MeV. In addition, differential cross sections for T(p,p)T were measured at energies of 16.230 and 19.480 MeV to provide supporting data for existing mass-4 studies at these energies. Related data are compared, and preliminary attempts to analyze the data with an energy-independent phase-shift-analysis program are discussed. Several sets of single-channel phase-shift solutions are given for maximum angular momentum L values of 3. These solutions are not unique. Simultaneous two- and three-channel analyses are inconclusive. Polarization asymmetry measurements using the Los Alamos Scientific Laboratory Lamb-shift polarized ion source show a maximum analyzing power of about +0.70 at 13.600 MeV for T($\vec{p}$,p)T. These values are related to existing analyzing-power measurements of ^{3}He($\vec{p}$,$\vec{p}$)^{3}He and T($\vec{p}$,$\vec{p}$)T near this energy. (auth)

45901 POLARIZATION IN n–p SCATTERING FROM 11 TO 29.6 MeV. Mutchler, G. S.; Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 67-73(Jul 1971).

Measurements of neutron–proton polarizations at 90° cm were made at 11.0, 16.8, 23.1, and 29.6 MeV. The results are 0.0130 ± 0.0049, 0.0280 ± 0.0060, 0.0502 ± 0.0040, and 0.0824 ± 0.0066, respectively. The T(d,n)^{4}He and D(t,n)^{4}He reactions were used as sources of monoenergetic polarized neutrons. At 23.1 MeV the polarization was also measured at 70° cm, and at 29.6 MeV additional measurements were made at 60 and 120° cm. The 90° data are related to the T = 1 spin-orbit P-wave splitting, Δ_{LS}. Comparisons were made with current phase-shift analyses, with the result that near 23 and 30 MeV these data give values of Δ_{LS} in accord with the analyses. Near 10 MeV the theoretical situation is less certain, and the data place limits on the value of Δ_{LS}. (auth)

45902 MULTIPLE-SCATTERING EXPANSIONS FOR MODERATE-ENERGY PARTICLE-DEUTERON SCATTERING. Ko-

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walski, K. L.; Pieper, S. C. (Case Western Reserve Univ., Cleveland). Phys. Rev., C; 4: No. 1, 74-80(Jul 1971).

A multiple-scattering expansion based on a fixed-scatterer approximation is conjectured to be more appropriate for discussing the small-angle elastic scattering of particles from deuterium than the expansion derived from the Faddeev equations. Some computations carried out for nucleon–deuteron scattering in the energy range 10 to 100 MeV seem to lend support to this conjecture. (auth)

45903 p-^{3}He ELASTIC SCATTERING FROM 13 TO 20 MeV. Hutson, R. L.; Jarmie, Nelson; Detch, J. L. Jr.; Jett, J. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 17-22(Jul 1971).

Accurate differential cross sections for protons elastically scattered by ^{3}He are presented for bombarding energies of 13.600, 16.232, and 19.480 MeV. The data have relative errors on the order of 0.7% and a scale error of 0.4%. The results are compared with the work of others, and phase-shift analyses are briefly discussed. (auth)

45904 n-^{4}He ELASTIC SCATTERING NEAR 20 MeV. Niiler, A.; Drosg, M.; Hopkins, J. C.; Seagrave, J. D.; Kerr, E. C. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 36-42(Jul 1971).

The differential cross sections for the elastic scattering of neutrons by ^{4}He were measured at incident neutron energies of 17.6, 20.9, and 23.7 MeV for lab angles between 20 and 140°. The cross sections were measured relative to the ^{1}H(n,n)^{1}H cross sections by the neutron time-of-flight technique. The 0.75-M ^{4}He scattering sample was a liquid contained in a thin-walled cryostat. Corrections were made for multiple scattering and attenuation. Phase-shift analyses were performed using both differential-cross-section and polarization data. The present phase shifts are joined to the well-established low-energy phase shifts and show a smooth energy dependence. (auth)

45905 EVEN-PARITY STATES OF THE FIVE-NUCLEON SYSTEM AND DEUTERON–TRITON PHOTOCAPTURE. Wagner, Robert F. (Catholic Univ. of America, Washington, D. C.); Werntz, Carl. Phys. Rev., C; 4: No. 1, 1-9(Jul 1971).

The non-normal-parity states for the five-nucleon system are obtained in the shell-model with particle–hole interactions. The residual force used is the separable smooth potential due to Tabakin. Coupling of the shell-model wave functions to deuteron and single-particle channels is calculated semiquantitatively, and the results are used in an R-matrix calculation of the cross section for photocapture of deuterons by tritons. A broad peak in the cross section at about 21 MeV excited energy due to capture through a $5/2^+$ state is predicted. (auth)

45906 (π^+,2p) REACTION IN LIGHT NUCLEI. Favier, J.; Bressani, T.; Charpak, G.; (and others) (CERN, Geneva). Nucl. Phys.; A169: No. 3, 540-76(1971).

The (π^+,2p) reaction with 76 MeV pions was studied on targets of ^{2}H, He, ^{6}Li, Li, Be, B, C, N, O, F, Al, S, Cl, Ca, Fe, and Pb. A complete determination of all the kinematic variables was made, except in the case of Pb, where only the integrated cross section was measured. Coincident protons were detected in two (E,dE/dX) counters placed symmetrically with respect to the pion beam at a mean angle of 76°. Cross sections are presented as functions of missing mass, recoil momentum, recoil angle, and Treiman–Yang angle. The missing-mass spectra show features at low energies (≈30 MeV) which vary from nucleus to nucleus. The recoil momentum spectra show that for ground state or low-excitation regions of the product nuclei, low recoil momenta are favored, as one would expect from a quasi-free absorption of the pion on a closely correlated pair of nucleons. This picture is confirmed by the Treiman–Yang angle distributions. Various theoretical models, all based on absorption of a pion by two correlated nucleons, are compared with the experimental results. It appears that the models are successful for reactions leading to the low excitation regions of the product nuclei. Some evidence is presented which indicates that the cross section in the geometry leading to high-excitation regions of the product nuclei are also due, in large measure, to pion capture by two correlated nucleons, but with considerable distortion of the incident pion and the emerging protons. (auth)

45907 KINEMATICS OF THE T(d,n)^{4}He REACTION. Oblozinsky, P.; Ribansky, I. (Inst. of Physics, Bratislava). Fyz. Cas.; 19: No. 4, 253(1969). (In Slovak).

The energy of the products of the T(d,n)^{4}He reaction was calculated. The calculated energies of neutrons and α-particles differ from previously reported values by 40 to 50 keV. (CA) (NSA of Czech)

45908 SPHERICAL HARTREE–FOCK CALCULATIONS WITH SUSSEX INTERACTION. Kakkar, I.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur). Can. J. Phys.; 49: 1874-8(15 Jul 1971).

Spherical Hartree–Fock calculations for ^{4}He, ^{12}C, and ^{16}O nuclei were carried out with Sussex relative matrix elements of Elliott et al. [Nucl. Phys. A, 121: 241-78(1968)]. It is observed that the calculated binding energies for all these nuclei are considerably smaller than the experimental values. However, the Sussex matrix elements give better results for the binding energies of these nuclei compared with the truncated results of other realistic interactions in most of the cases. The rest of the calculated properties are in fair agreement with experiments. (auth) (Canada)

45909 IMAGINARY POTENTIAL IN RESONATING-GROUP CALCULATIONS FOR THE $\alpha + \alpha$ SYSTEM. Brown, Ronald E.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Nucl. Phys.; A170: No. 2, 225-39(1971). (COO–1265-108).

Resonating-group calculations have been quite successful in describing the $\alpha + \alpha$ system below the reaction threshold of 17.36 MeV (c.m.). In order to extend these calculations to energies above this threshold, a local, phenomenological, imaginary potential is introduced into the usual resonating-group formulation; the purpose being to account approximately for the influence of reactions on the elastic scattering. It is found that a simple, surface-peaked, imaginary potential with a strength which varies smoothly with energy is quite adequate to reproduce the imaginary parts of the experimentally determined $\alpha + \alpha$ phase shifts from 25 to 60 MeV (c.m.). The introduction of such a potential is found to cause only a small change in the calculated real parts of the $\alpha + \alpha$ phase shifts. The agreement of these calculated real phases with those determined from experiment is better below the reaction threshold than above it. A discussion is given of $\alpha + \alpha$ effective potentials, and the influence of the imaginary potential on the real, effective potential is investigated. (auth)

45910 FINAL-STATE INTERACTIONS IN THE REACTION T(^{3}He,^{4}He)np. Beveridge, J. L.; Johnson, R. R. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: 1374-83 (15 May 1971).

A triple correlation cross section was measured for the reaction T(^{3}He,^{4}He)np in a complete experiment at a ^{3}He bombarding energy of 1.5 MeV. The Watson–Migdal and Phillips, Griffy, and Biedenharn (PGB) final state interaction theories are compared in the analysis of the experimental data. The Watson–Migdal theory gives a good description of both the ^{5}He ground state and singlet n–p cross section enhancements. One form of the PGB theory gives a prediction of the singlet n–p enhancement which is indistinguishable from the Watson–Migdal prediction in this experiment. The measured cross section was found to be dominated by direct statistical breakup and sequential decay through a virtual singlet n–p state and the ground state of ^{5}He. A singlet n–p scattering length of $a^s_{np} = -21^{+3}_{-4}$ F was determined from the analysis of the three-body data. The reaction T(T,^{4}He)2n is similar to the reaction T(^{3}He,^{4}He)np. Consequently using a complete experimental technique to estimate the a^s_{nn} from T(T,^{4}He)2n would lead to similar error estimates, i.e. $a^s_{nn} \simeq \pm 4$F. (auth) (Canada)

45911 NUCLEON AND DEUTERON REDUCED WIDTHS OF THE POSITIVE PARITY (T = ½) STATES OF THE MASS-5 SYSTEM. Ramavataram, S.; Ramavataram, K. (Univ. Laval, Quebec). Can. J. Phys.; 49: 1798-1804(1 Jul 1971).

Reduced widths for nucleon and deuteron emission from the positive parity (T = ½) states in the region of 16 to 20 MeV excitation in the mass-5 system were calculated using the R-matrix theory. Shell model wave functions were employed to describe the relevant states. Excellent agreement is obtained with various aspects of the experimental results on the well-established $3/2^+$ resonance at 16.6 MeV. Values for the proton and deuteron partial widths and the γ_d^2/γ_p^2 ratio for the $1/2^+$ resonance at 18 MeV and $5/2^+$ resonance at 20 MeV are presented. The calculated proton partial width for the $5/2^+$ resonance is in the range of values estimated from recent analysis of the p-^{4}He phase-shift data. (auth) (Canada)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 44673, 44742, 45628, 45770, 45818, 45837, 45874, 45884, 45897, 45898, 45899, 45906, 45908, 45952, 45971–45973, 45999, 46001, 46002, 46021, 46025, and 46144.

45912 (CEA-N-1390, pp 91-137) INVESTIGATIONS WITH THE CYCLOTRON. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

Topics covered are: the facilities under construction or being studied in connection with the variable energy cyclotron (injection, ion sources); interpretation of 24 MeV inelastic polarized proton scattering by ^{14}N and ^{208}Pb; inelastic scattering of polarized or unpolarized 24 MeV protons by deformed ^{152}Sm, ^{158}Gd, and ^{176}Hf nuclei; 20 MeV inelastic polarized proton scattering by ^{26}Mg; ^{12}C (p,p') and ^{12}C (p,d) reactions with 24 MeV polarized protons; the ^{49}Ti (p,d) ^{48}Ti reaction at 20 MeV; the ^{92}Mo (p,d) ^{91}Mo reaction at 24 MeV; measurement of the depolarization parameter in the elastic proton scattering by ^{27}Al, ^{9}Be, and ^{10}B; the ^{40}Ca (^{3}He,t) ^{40}Sc transfer reaction at 30 MeV; ^{9}Be (^{3}He,t) ^{9}B and ^{9}Be (p,n) ^{9}B transfer reactions at 30 MeV and 12 MeV respectively; experimental techniques (semiconductor particle detectors, ion implantation particle detectors, electronic on-line computers, the 1 GeV high resolution magnetic spectrometer project for Saturne with a localization proportional counter using charge division or migration). (France)

45913 (CEA-N-1390, pp 139-98) INVESTIGATIONS WITH THE LINEAR ACCELERATOR. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

Topics covered are: performance of the ALS electron and positron beams and the ALS facilities under construction; $^{16}O(\gamma,p_0)^{15}N$ photonuclear reaction at 300 MeV; electronics of the range telescopes for pions and protons; elastic electron scattering by ^{12}C at 375 MeV; inelastic electron scattering by ^{90}Zr and ^{92}Mo at 200 and 300 MeV; experimental equipment for elastic scattering and inelastic scattering (e,e') (e,e'p) experiments; characteristics of the first pion and muon channel of the ALS; background noise in neutrino experiment; experimental techniques including semiconductor particle detectors, multiwire chambers, electronics, computers, magnetic measurements, determination of the H concentration inside a closed room. (France)

45914 (ITF-71-20-P) VARIATIONAL CALCULATIONS OF THE BINDING ENERGY AND DIMENSIONS OF LIGHT NUCLEI. Zhukov, M. V.; Maksimenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A comparison of calculated results obtained by different variational methods for the binding energy and dimensions of light magic nuclei up to ^{40}Ca is carried out. The test functions used are the wave function of the K-harmonic method in the approximation $K = K_{min}$ and the shell-model wave function constructed on the wave functions of separate nucleons located in the central-symmetrical oscillator field. The comparison shows that, for the Gaussian-shape smooth potentials, both methods give similar results. (auth)

45915 (ORNL-4694) HYDROGEN AND HELIUM PARTICLES PRODUCED BY 59-MeV ALPHA PARTICLE BOMBARDMENT OF ^{12}C, ^{16}O, AND ^{54}Fe. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 46p. Dep. NTIS.

Differential cross sections are presented for the production of protons, deuterons, tritons, and alpha particles from ^{12}C and ^{54}Fe bombarded by 58.8-MeV alpha particles. Spectra are presented for the same particles from ^{16}O, but with rather large uncertainty. Continuum cross sections in 1- or 2-MeV wide bins are listed for 5-6 angles and with low-energy cutoffs which range from ~2-7 MeV, dependent on the type of exit particle. Angle-integrated and energy-integrated cross sections are also given. Total integral cross sections are given for emission of the five hydrogen and helium ions. Comparisons are shown between the (α,xα) and (p,xp) reaction in ^{54}Fe and ^{12}C for E_α and E_p about 60 MeV. (auth)

45916 (RLO-1388-136) ANGULAR MOMENTUM DEPENDENCE OF THE IMAGINARY POTENTIAL FOR HEAVY ION REACTIONS. Vandenbosch, R. (Washington Univ., Seattle). [1971]. 13p. (CONF-710209-4). Dep. NTIS.

From International conference on heavy ion physics; Dubna, USSR (11 Feb 1971).

The excitation function for elastic scattering of ^{18}O by ^{18}O was measured from 10 to 27 MeV. The data are interpreted by introducing an angular-momentum-dependent imaginary potential and considering the maximum angular momentum that can be carried away by any of the nonelastic direct-reaction channels. The results of coupled-channels calculations for $^{16}O + ^{16}O$ inelastic scattering and $^{18}O + ^{16}O$ elastic scattering are also given. (R.W.R.)

45917 STRUCTURE OF THE FIRST EXCITED 0^+ STATE OF ^{16}O. Suekane, Shota; Yura, Tadayoshi (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 2, 654-6(Feb 1971).

There have been difficulties in understanding the low-lying positive-parity states of ^{16}O in terms of the coexistence of a spherical 0p-0h state and deformed 2p-2h and 4p-4h states. The Hartree-Fock energy (E_{HF}) is calculated for the 0p-0h and 4p-4h states in a single-major shell Hartree-Fock calculation, and its dependence on the oscillator length is given. It is concluded that the two main difficulties of the coexistence model of ^{16}O can be resolved by consideration of the finite nuclear size and the expansion of the single-particle potential due to excitation. (R.W.R.)

45918 CLUSTER-MODEL CALCULATION OF $^{6}Li(\pi^-,nn)^{4}He$. Park, S. C.; Rickett, J. P. (Baylor Univ., Waco, Tex.). Phys. Rev., C; 3: No. 5, 1926-35(May 1971).

The two-nucleon pion-absorption operator of Koltun and Reitan is applied to the pionic disintegration process of ^{6}Li. The target nucleus is represented by the cluster-model wave function of Tang, Wildermuth, and Pearlstein. The pion-absorption operator is of nonzero-range character and takes into account both the direct-absorption and the rescattering processes. The transition probability of the decay turns out to depend on the two parameters associated, respectively, with the intercluster distance and the size of the deuteron in ^{6}Li. The values of these two parameters are determined so as to fit the experimental momentum distribution of the two final neutrons to within experimental error. The possibility of the existence of a second peak in the momentum distribution is also discussed. (auth)

45919 POLARIZATION AND ANGULAR DISTRIBUTION OF THE NEUTRONS FROM $^{14}C(p,n)$ REACTION AND THE TENSOR FORCE. Wong, C. (Univ. of California, Livermore); Anderson, J. D.; Madsen, V. A.; (and others). Phys. Rev., C; 3: No. 5, 1904-20(May 1971).

The polarization of the neutrons from the $^{14}C(p,n)$ reaction leading to the first three levels of ^{14}N was measured at six bombarding energies between 7.2 and 13.3 MeV. The polarization and angular distribution of the neutrons leading to the two 1^+ states were analyzed with a microscopic distorted-wave Born-approximation formalism that has been extended to include spin-orbit optical distortions and a tensor component in the effective two-body force; the analog-state transition has been analyzed with the Lane model. The angular distribution and polarization shapes for the analog transition are not well reproduced by the Lane model, primarily because of lack of precise optical parameters as a function of bombarding energy. However, the integrated cross sections between 8.8 and 18.3 MeV are reasonably well accounted for with a constant real and imaginary isospin strength of 88 and 40 MeV, respectively. The corresponding real microscopic charge-exchange strength is $V_\tau = 9$ MeV for a Yukawa form factor of range 1.4 fm. The calculated 1^+ angular-distribution shapes are in fair agreement with measurements and are consistent with a constant central spin-spin and tensor strength between 10.4- and 18.3-MeV bombarding energy: $V_{\sigma\tau} = 7 \pm 1$ MeV and $V_T = 4.7 \pm 0.7$ MeV, although there is some indication that the tensor strength is decreasing with increasing energy. Contrary to the angular-distribution measurements, the 1^+ polarization measurements do not clearly favor a tensor component in the effective two-body force; neither the pure central nor the central-plus-tensor polarization calculation fits the data particularly well. This disagreement is probably due to optical-parameter uncertainties and contributions from second-order processes, and possibly to the neglect of tensor exchange and small admixtures of intermediate-structure resonance processes. (auth)

45920 ACCURATE EXCITATION ENERGIES OF ^{14}N UP TO 9.4 MeV. Duray, J. R.; Brown, C. P. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 3: No. 5, 1867-70(May 1971).

Precision excitation energies of 16 levels in ^{14}N measured with the $^{12}C(^{3}He,p)^{14}N$ reaction are reported. The values based on an assumed excitation energy for the fourth excitated state of 5105.87 keV are 3950.2, 4915.3, 5688.8, 5832.4, 6202.5, 6444.9, 7027.9, 7964.9, 8486.4, (8617.4), 8909.9, 8959.8, (8977.3), 9124.1, 9167.4, and 9385.4 keV. Random uncertainties range from 1.4 to 1.9 keV. The width of the 8909.9-keV level was measured as 19.7 ± 1.9 keV and that of the 9385.4-keV level as 15.6 ± 2.0 keV. Angular distributions measured at 11.95 MeV are given for these 16 levels and for the 5106-keV level. The states at 2312, 8063, and 8710 keV were not measured. (auth)

45921 GAMMA DECAYS OF THE FIRST T = ½ STATES IN ^{9}Be AND ^{9}B. Adloff, J. C.; Souw, K. H.; Cocke, C. L. (Institut de Recherches Nucleaires, Strasbourg). Phys. Rev., C; 3: No. 5, 1808-21(May 1971).

The reactions $^{7}Li(^{3}He,p)^{9}Be(14.39\ MeV)(\gamma)$ and $^{7}Li(^{3}He,n)^{9}B(14.67\ MeV)(\gamma)$ have been used to study the γ-decay modes of the first T = ½ states in ^{9}Be and ^{9}B. γ spectra from a NaI detector were recorded in coincidence with proton energy spectra from the $^{7}Li(^{3}He,p)$ reaction, and with neutron time-of-flight spectra from the $^{7}Li(^{3}He,n)$ reaction. In addition, the singles γ spectrum from

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the 14.39-MeV state in ^{9}Be was studied using a Ge-Li detector. The γ spectrum from the Ge-Li detector gives the branching ratio $\Gamma_{\gamma(2.43)}/\Gamma_{\gamma 0} = 1.19 \pm 0.16$ for the decay of the first T = $^3/_2$ state in ^{9}Be. From the γ-n coincidence spectrum below threshold for production of ^{9}B(14.67 MeV) a γ decay from ^{9}Be(14.39 MeV) to a state in ^{9}Be at $E_x = 2.9 \pm 0.25$ MeV was found. The total width of this state was found to be $\Gamma = 1.0 \pm 0.25$ MeV. A measurement of the strength of this γ branch relative to that to ^{9}Be(2.43 MeV) yields $\Gamma_{\gamma(2.9)}/\Gamma_{\gamma(2.43)} = 0.30 \pm 0.04$. From the γ-n spectra above the ^{9}B(14.67 MeV) threshold a γ-decay spectrum from the (14.67-MeV) state in ^{9}B was obtained which shows consistency with the branching ratios obtained for ^{9}Be(14.39 MeV). Combining branching ratios with previously available information gives a best set of radiative widths from the first T = $^3/_2$ levels in ^{9}Be and ^{9}B. From the coincidence spectra the value for $\Gamma_{\gamma 0}/\Gamma_{tot}$ is found to be 0.021 ± 0.004 for ^{9}Be(14.39 MeV). The ratios of the total widths $\Gamma_{tot}(^9\text{Be}(14.39\text{ MeV}))/\Gamma_{tot}(^9\text{B}(14.67\text{ MeV}))$ are deduced as 1.23. When combined with the value for $\Gamma_{\gamma 0}(^9\text{Be}(14.39\text{ MeV}))$, these ratios yield $\Gamma_{tot} = 0.50 \pm 0.1$ keV (^{9}Be) and 0.4 keV (^{9}B) for the total widths of the two states. (auth)

45922 SEARCH FOR EXCITED STATES IN ^{3}He. Bray, K. H.; Bunker, S. N.; Jain, Mahavir; (and others) (Univ. of Manitoba, Winnipeg). Phys. Rev., C; 3: No. 5, 1771-85(May 1971).

A search has been made for excited states in ^{3}He by investigating proton-induced reactions on ^{6}Li. The investigation consisted of two parts. In the first part, a kinematically incomplete experiment, the ^{3}He and α-particle continua from the ^{6}Li(p,^{3}He) and ^{6}Li(p,α) reactions at an incident proton energy of 45.0 MeV have been studied for structure due to excited states in ^{4}He and ^{3}He, respectively. The ^{3}He and α-particle spectra were measured from 15 to 90° (lab) in steps of 5° using a ΔE-E detector telescope. The ^{3}He spectra exhibit clearly discernible peaks due to the 20.2-MeV (0^+, T = 0) and 21.4-MeV (0^-, T = 0) excited states in ^{4}He. In the α-particle spectra no structure has been observed that could be interpreted as due to excited states in ^{3}He for excitation energies up to 17.5 MeV. An upper limit of 30 μb/sr could be set for the excitation of states in ^{3}He having a width $\lesssim$1.0 MeV. In the second part, a kinematically complete experiment, a study has been made of the ^{6}Li(p,αd)p reaction at an incident proton energy of 45.0 MeV. This investigation was carried out to study final-state interactions and, in particular, to search for a possible p-d final-state interaction corresponding to a resonance in ^{3}He. Coincidence spectra from the ^{6}Li(p,αd)p reaction were measured in coplanar geometry with the α-particle detector set at 50° (lab), while the deuteron-detector telescope was moved in steps of 10° from −100 to −50° (lab), and with the α-particle detector set at 30° (lab) and the deuteron-detector telescope at −100 and −80° (lab). The measured coincidence spectra show a prominent p-α final-state interaction corresponding to the ground state of ^{5}Li. No other strong p-α final-state interaction was observed. The coincidence spectra do not exhibit a p-d final-state interaction corresponding to a T = $^1/_2$ resonance in ^{3}He of excitation between 5.5 and 20 MeV. (auth)

45923 EXCITATION OF THE GIANT RESONANCE IN ^{12}C BY INELASTIC ELECTRON SCATTERING. Yamaguchi, A.; Terasawa, T.; Nakahara, K.; Torizuka, Y. (Tohoku Univ., Sendai). Phys. Rev., C; 3: No. 5, 1750-69(May 1971).

The longitudinal and transverse form factors were determined separately as functions of the excitation energy from 15 to 40 MeV in the momentum-transfer range 0.75-1.56 F^{-1}. For some of the form-factor spectra the measurements were extended up to an excitation energy of 100 MeV and the results were compared with the quasielastic model presented by de Forest. The q dependence of the experimental form factors for levels was compared with the predictions of the particle-hole model and with the intermediate-coupling model. The levels with the following excitation energies (MeV), spins, and parities: 18.1 (1^-), 18.6 (3^-), 19.6 (4^-), 20.0 (2^+), 20.6 (3^+), 21.6 (3^-), 22.0 (1^-), 22.7 (1^-), and 23.8 (1^-) were found. New evidence of the possibility of the spin-isospin mode for the 22.7-MeV (1^-) excitation was found. (auth)

45924 NEUTRON CAPTURE CROSS SECTIONS OF ^{13}C AND ^{16}O. Allen, B. J. (Australian Atomic Energy Commission, Lucas Height. Oak Ridge National Lab., Tenn.); Macklin, R. L. Phys. Rev., C; 3: No. 5, 1737-40(May 1971).

Measurements have been made of the radiative widths of the lowest energy resonances in ^{13}C and ^{16}O. Maxwellian-averaged capture cross sections calculated for kT = 30 keV indicate that ^{13}C and ^{16}O could not have been significant neutron poisons in s-process nucleosynthesis. (auth)

45925 SCATTERING OF 19- TO 30-MeV ALPHA PARTICLES FROM ^{16}O. Bergman, Clark; Hobbie, Russell K. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 3: No. 5, 1729-37(May 1971).

α-particle scattering by ^{16}O has been studied in the energy range 18.9 to 30 MeV, using the Minnesota MP tandem Van de Graaff accelerator. The target consisted of 40 μg/cm^2 of oxygen in the form of LiOH on a 20-μg/cm^2 carbon backing. Absolute cross sections were determined with an oxygen gas target. Excitation functions were measured in 20-keV steps at eight angles over the entire energy range, using computer control of the accelerator's analyzing magnet. The center-of-mass angles were selected to be zeros of the Legendre polynomials P_1 to P_9 for elastic scattering. Inelastic scattering to the 6.05−6.13-MeV doublet in ^{16}O was also studied. Elastic differential cross sections were measured at 20 energies between 18.9 and 23.0 MeV. Nonstatistical structure is observed in the excitation functions. The spins and parities of the resonances are tentatively assigned on the basis of the elastic excitation functions. A phase-shift analysis of the differential cross sections has unambiguously identified $J^\pi = 9^-$ resonances at 20.70 MeV (Γ = 120 keV) and 21.10 MeV (Γ = 80 keV) in ^{20}Ne. They may be the 9^- members of the lowest-two negative-parity rotational bands in ^{20}Ne, which are expected to be near 20 MeV. (auth)

45926 INFLUENCE OF DIFFERENT BACKING MATERIALS ON LIFETIMES IN DOPPLER-SHIFT MEASUREMENTS. Bister, M.; Anttila, A.; Piiparinen, M.; Viitasalo, M. (Univ. of Helsinki). Phys. Rev., C; 3: No. 5, 1972-5(May 1971).

The mean lives of the 2312-, 3947-, and 6203-keV levels of ^{14}N have been measured with the Doppler-shift-attenuation (DSA) method through the reaction ^{13}C(p,γ)^{14}N (E_p = 1.15 MeV) using C, Ti, Ag, Mo, Ni, Ta, Au, and W as stopping materials. ^{13}C ions were separated both onto and into the backings. The results show in this case about ±20% anomalies. Some sources of error arising from target preparation are discussed. In DSA measurements of short lifetime the use of implanted targets seems to be advantageous. The measured lifetimes are given as 70 ± 10, 10.5 ± 3.5, and 118 ± 13 fsec, respectively. (auth)

45927 INTERFERENCE OF ^{8}Be LEVELS AND FINAL-STATE COULOMB INTERACTIONS. Norbeck, E.; Gadeken, L. L.; Ingram, F. D. (Univ. of Iowa, Iowa City). Phys. Rev., C; 3: No. 5, 2073-4(May 1971).

Recent precision measurements of the interfering levels in ^{8}Be at 16.6 and 16.9 MeV are in good agreement with a simple two-level formula with interference when it is properly corrected for the effects of final-state Coulomb interactions. The widths used in the formula are $\Gamma(16.6)$ = 90 keV and $\Gamma(16.9)$ = 70 keV. It is not necessary to assume that the T = 1 components of the ^{8}Be wave functions are excited in the reactions ^{10}B(d,α)^{8}Be* and ^{6}Li(^{6}Li,α)^{8}Be*. Using the latter reaction, it is shown that the background is too small to have an appreciable effect on the spectral shape for the two levels. (auth)

45928 ^{16}O(n,α)^{13}C REACTION AT 13.9 MeV. Brede, H. J.; Moerike, M.; Schuerenberg, B.; Staudt, G.; Weng, F. (Univ., Tuebingen, Ger.). Z. Phys.; 245: No. 1, 1-12(1971).

The reaction ^{16}O(n,α)^{13}C was studied with 13.9 MeV neutrons using two different counter telescopes. Absolute differential cross sections were measured for the transitions to the ground state and to the 3.08 and 3.68 + 3.85 MeV levels of ^{13}C. The results are interpreted in terms of a direct reaction mechanism. (auth)

45929 FINAL-STATE INTERACTIONS IN THE ^{9}Be + p → d + 2α REACTION. Emerson, S. T.; Valkovic, V.; Jackson, W. R.; (and others) (Rice Univ., Houston, Tex.). Nucl. Phys.; A169: No. 2, 317-36(1971).

The ^{9}Be + p → d + 2α reaction has been studied at a proton bombarding energy of 9.0 MeV, by the coincident detection of pairs of reaction products. Mass identification of one detected particle has been accomplished using a time-of-flight technique. The reaction yield has been shown to be dominated by final-state interactions through states in ^{8}Be and ^{6}Li, with little or no yield from direct three-body disintegration. Theoretical fits to the data using the generalized density of states functions reproduce quite accurately the shapes of the spectra. Efforts to fit the angular dependence of the yield have met with limited success. (auth)

45930 STUDY OF THE ^{16}O(p,pα)^{12}C AND THE ^{20}Ne(p,pα)^{16}O REACTIONS AT 46.8 MeV. Epstein, M. B.; Quinn, J. R.; Bunker, S. N.; Verba, J. W.; Richardson, J. Reginald (Univ. of California, Los Angeles). Nucl. Phys.; A169: No. 2, 337-52(1971).

The cross sections for the reactions ^{16}O(p,pα)^{12}C and ^{20}Ne(p,pα)^{16}O were measured at 46.8 MeV incident energy. An attempt was made to observe quasi-elastic p−α scattering. Within the context of the impulse approximation no clear evidence for this reaction mechanism was observed. These reactions appear to be dominated by sequential processes. (auth)

45931 INELASTIC PHOTOPRODUCTION OF PIONS ON NUCLEI AND DETERMINATION OF THE ISOSCALAR PART

OF THE ELECTRIC DIPOLE AMPLITUDE. Rej, A. K. (Indian Statistical Inst., Calcutta). Progr. Theor. Phys. (Kyoto); 45: No. 3, 992-4(Mar 1971).

The use of linearly polarized photons perpendicular to the production plane is suggested for a study of inelastic photoproduction of π^0 on ^{7}Li. This reaction leads to the isobaric quartet state at 11.13 MeV and can be used to study the $E_0^{(0)}$ amplitude along if the measurement is made at 90°. A theoretical expression for the differential cross section is derived. (R.W.R.)

45932 EFFECTIVE INTERACTIONS BETWEEN INEQUIVALENT NUCLEONS IN THE 1p AND 2s, 1d SHELLS. Hsieh, S. T.; Lee, T. Y.; Chen-Tsai, C. T. (Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 4: No. 1, 105-7(Jul 1971).

The effective interactions between inequivalent nucleons in the 1p and 2s–1d shells are investigated from an exact shell-model calculation via a least-squares fit of the experimental energy spectra of the nonnormal-parity states in oxygen isotopes. (auth)

45933 PARTICLE–PARTICLE ANGULAR-CORRELATION MEASUREMENTS MAKING USE OF A POSITION-SENSITIVE DETECTOR. Schwalm, D.; Traxel, K.; Weiss, H.; Morando, M.; Povh, B. (Univ., Heidelberg. Max-Planck Institut fuer Kernphysik, Heidelberg). Phys. Rev., C; 4: No. 1, 10-16(Jul 1971).

A new experimental setup for measuring particle–particle angular correlations with a position-sensitive detector is presented. The method was investigated using the reaction $^{12}C(^{12}C,\alpha_1)^{20}Ne(\alpha_2)^{16}O$. The first α particle was detected in a telescope located at 0°, whereas the second one was measured in a 55-mm-long position-sensitive detector covering angles between 30 and 110°. From the measured correlation functions the spins of the intermediate ^{20}Ne states can be determined uniquely. A new $J^\pi = 7^-$ state was found at an excitation energy of 16.5 ± 0.3 MeV. (auth)

45934 ENERGY DEPENDENCE OF PROXIMITY SCATTERING. Thievent, G.; Land, J.; Mueller, R.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A170: No. 1, 17-33(1971).

A nuclear reaction with three outgoing particles can proceed in two sequential stages, one of the product particles of the first step being unstable. Under certain conditions two of the three particles in the final state can undergo a further reaction (proximity scattering). In order to show the contribution of this process unambiguously, it is necessary to observe it at different energies of the incident particles. The α-n proximity scattering of the neutron and of one of the α-particles emitted in the decay of ^{8}Be in the reaction $^7Li(d,n\alpha)^4He$ has been studied at different energies of the incident deuterons between 2.07 and 2.25 MeV. A quantal calculation of the reaction cross section is presented, assuming that the contribution of a few simple diagrams is important. (auth)

45935 QUADRUPOLE MOMENT OF Li. Green, Sheldon (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 4: No. 1, 251-3(Jul 1971).

The electric field gradient at Li in LiH was computed with a 200 configuration-interaction function including single and double excitations from the Hartree–Fock function of Cade and Huo. This value, in conjunction with the experimental LiH eqQ value, leads to a suggested value of $Q(^7Li) = -(3.66 \pm 0.03) \times 10^{-26}$ cm^2. This value is substantially different from that obtained using previously calculated field gradients derived from less complete wave functions. (auth)

45936 DYNAMIC NUCLEAR EFFECTS IN MESIC ATOMS. Haff, Peter Kirkland. Charlottesville, Va.; Univ. of Virginia (1970). 162p. University Microfilms Order No. 71-6620.

Thesis.

Until recently, dynamic nuclear mixing of nuclear states in muonic atoms has not been considered in either pionic or kaonic atoms, as the strong absorption means that the meson in almost all cases occupies states of non-zero angular momentum and, hence, has poor overlap with the nucleus. Nevertheless, because pions and kaons may be used as tools to examine rather fine details of the nuclear structure, it is worthwhile to check quantitatively that the nuclear structure being studied is actually that of the nuclear ground state. With suitable assumptions about the strong-interaction potential, all intermediate meson states are summed in first-order perturbation theory to calculate nuclear excitation probabilities and corrections to (static) absorption widths. In particular, the mixing of photonuclear giant resonance states in spherical nuclei and of the lowest member of the ground-state rotational band in deformed nuclei are examined. Mixing of some low states in vibrational nuclei is also considered. The effects of dynamic nuclear mixing appear negligible except perhaps in the light nuclei and the deformed nuclei. In the light nuclei the 1s absorption width-in ^{16}O is decreased by 12% through mixing of the photonuclear giant resonance. Rough estimates of width corrections in ^{19}F and ^{23}Na indicate that this effect will probably not account for any saturation effect observed in the 1s widths. In the deformed nuclei there may be a few-percent admixture of rotational states. This appears to be particularly important in kaonic atoms; the kaon absorption width is increased by a possible 25%. Attempts to explore the nuclear stratosphere of these elements by a static treatment of the kaon interaction must be viewed with suspicion. (Diss. Abstr. Int., B)

45937 CLUSTER-MODEL VERTEX FUNCTIONS FOR ^{16}O: BACKWARD α-PARTICLE SCATTERING. Noble, J. V.; Coelho, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C.; 3: No. 5, 1840-7(May 1971).

It is shown by direct calculation that the heavy-particle-transfer model of backward elastic α-particle scattering, together with the assumption of α-cluster structure of ^{16}O and ^{12}C, is capable of explaining the large backward peak in elastic α scattering from ^{16}O. (auth)

45938 COUPLED-CHANNEL EQUATIONS AND THE GIANT DIPOLE RESONANCE. Baur, G.; Alder, K. (Univ., Basel). Helv. Phys. Acta; 44: No. 1, 49-76(15 Feb 1971).

The cross section for the (γ,nucleon) reaction with nuclei in the giant resonance region is calculated in a coupled-channel model. One-particle–one-hole excitations and collective surface vibrations, which are coupled to the particle degrees of freedom, are considered. It is shown that the coupled-channel equations may be simplified by using the "external mixing" approximation. Furthermore, the interference of E1- and E2-radiation and its influence on the angular distribution are calculated. Numerical calculations are done for the giant dipole resonance in ^{12}C and ^{16}O and compared with the experimental data. Contrary to the usual bound-state calculations, this model makes explicit predictions for the various observable quantities, such as total cross sections for photodisintegration and their angular distributions. (auth)

45939 EXPERIMENTAL STUDY OF THE FIRST EXCITED STATE OF ^{9}Be. Gerardin, C.; Seltz, R.; Magnac-Valette, D. (CRN–CNRS, Strasbourg). Nucl. Phys.; A169: No. 3, 521-39 (1971). (In French).

The origin of the α-group from the $^{10}B(t,\alpha)$ reaction, sometimes but not always supposed to be associated with a level of ^{9}Be between 1.65 and 1.80 MeV, has been carefully analyzed as a monokinetic group by comparing the experimental variation of the peak versus the angle of emission for E_t = 1–3 MeV with other different possible theoretical processes: two-step reactions, three-step reactions and breakup with or without interaction in the final state. The excitation has been measured at 1750 ± 25 keV, the corresponding width is 220 ± 8 keV. The results of the same study with $^9Be(\alpha,\alpha')^9$Be are in agreement with these values. The angular distribution of the peak of $^{10}B(t,\alpha)^9$Be (1.75 MeV) has been analyzed in DWBA at E_t = 2.5 MeV as a pick-up process and is, under this hypothesis, in agreement with $J^\pi = 1/2^+$. The parameters for the ingoing channel are deduced from a measurement of $^{10}B(t,t)^{10}$B elastic scattering between 1 and 3 MeV. (auth)

45940 APPLICATION OF THE WEAK COUPLING MODEL TO THE NEGATIVE-PARITY STATES OF THE A = 15 NUCLEI. Lie, S.; Engeland, T. (Univ. of Oslo). Nucl. Phys.; A169: No. 3, 617-28(1971).

The negative-parity states for A = 15 were investigated in a weak coupling model. Based on particles in the sd shell and holes in the p-shell the final eigenstates are found to be admixtures of 0p-1h, 1p-2h T_h = 0 and 1p-2h T_h = 1 configurations. Good agreement is obtained with the experimental energy levels below 11 MeV. The correspondence between levels in ^{15}N and ^{15}O is discussed. (auth)

45941 RESULTS FROM MEDIUM-ENERGY INTRANUCLEAR-CASCADE CALCULATION. Bertini, Hugo W.; Guthrie, Miriam P. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A169: No. 3, 670-2(1971).

An appreciable quantity of data has been generated using a medium-energy intranuclear-cascade calculation. Reactions were calculated for incident neutrons, protons and charged pions on five elements ranging from oxygen to lead. The energy range of the incident nucleons was from 500 to 3000 MeV in 500 MeV steps and, similarly, the energy range of the incident pions was from 500 to 2500 MeV. Data from the cascade and evaporation phases are available. A preliminary version of the computer programs used to generate the data is also available. The final version of the programs will be made available in the near future. (auth)

45942 STUDY OF DISTORTION IN COPLANAR AND NON-COPLANAR REACTIONS $^{12}C(p,2p)^{11}B_{1p_{3/2}}$ AND $^{40}Ca(p,2p)^{39}K_{2s_{1/2}}$ AT 156 MeV. Hourany, E.; Yuasa, T.; Didelez, J. P.; (and others)

XUM

(Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A162: 624-42(1971). (In French).

The cross section for the symmetric (p,2p) reaction on ^{12}C and ^{40}Ca is measured with range telescopes, in coplanar and non-coplanar geometries at 156 MeV. The interpretation is given in the simple impulse approximation and in the DWIA using an optical potential deduced from proton elastic scattering. (auth)

45943 DETERMINATION OF OXYGEN AND NITROGEN IN GASES BY PROMPT GAMMA RAY MEASUREMENT. Macey, D. J.; Bilboy, W. B. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 92: No. 4, 501-4(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The yields of prompt gamma rays emitted by oxygen and nitrogen during deuteron bombardment were measured using a Ge(Li) detector. Relative excitation functions for the reactions $^{16}O(d,p\gamma)^{17}O$, $^{14}N(d,p\gamma)^{15}N$, and $^{14}N(d,n\gamma)^{15}O$ were determined for deuterons in the energy range 1 to 3 MeV. Detection limits for the determinations of oxygen and nitrogen in gases are given. (auth)

45944 GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING IN OXYGEN. Lundberg, B.; Stroemberg, L. G.; Conde, H. (Forsvarets Forskningsanstalt, Stockholm). Phys. Scr.; 2: No. 6, 273-6(1970).

The differential cross section for the production of the 6.13 MeV gamma ray from the $^{16}O(n,n'\gamma)$ reaction has been measured between the reaction threshold and 8.2 MeV. The gamma rays were detected with a large NaI(Tl) crystal using time-of-flight techniques. Angular distributions have been studied at two resonance energies in the cross section, viz. 6.87 and 7.82 MeV. Spins for the involved levels in the compound nucleus are proposed and the shapes of the angular distributions are compared with calculations based on the compound nucleus model. The results are also compared with previously reported measurements. (auth) (Sweden)

45945 RADIATIVE YIELD OF THE E_α = 1.68 MeV RESONANCE IN THE $^{15}N(\alpha,\gamma)^{19}F$ REACTION. Dixon, W. R.; Storey, R. S. (National Research Council of Canada, Ottawa). Can. J. Phys.; 49: 1714-23(1 Jul 1971).

The radiative yield of the E_α = 1.68 MeV resonance in the $^{15}N(\alpha,\gamma)^{19}F$ reaction was measured by three different methods. These methods are: (1) a comparison with the E_α = 1.53 MeV resonance in the $^{14}N(\alpha,\gamma)^{18}F$ reaction; (2) a comparison with the E_p = 0.898 MeV resonance in the $^{15}N(p,\alpha\gamma)^{12}C$ reaction; and (3) an absolute determination based on an efficiency calibration of the detector with a standard radioactive source. The final result is $\omega\gamma = [(2J+1)/2]\,(\Gamma_\alpha\Gamma_\gamma/\Gamma)_{c.m.} = 1.64 \pm 0.16$ eV. (auth) (Canada)

45946 CHARGE-EXCHANGE SCATTERING OF PIONS OF ^{14}N. Maclin, A. P.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Can. J. Phys.; 49: 1826-7(1 Jul 1971).

Cross sections for the reaction $^{14}N(\pi^+,\pi^0)^{14}O$ are calculated near the (3,3) resonance using the impulse approximation together with the Chew–Low amplitude in the framework of a two-hole shell model formalism. Various sets of wave functions are used and comparisons are made with existing experimental data and other theoretical calculations. (auth) (Canada)

45947 REACTION CROSS-SECTION AND RESONANCE INTEGRAL FOR $^{18}O(n,\gamma)^{19}O$. Blaser, W.; Wyttenbach, A.; Baertschi, P. (Federal Inst. for Reactor Research, Wuerenligen, Switzerland). J. Inorg. Nucl. Chem.; 33: 1221-5(May 1971).

The cross-section for the reaction $^{18}O(n,\gamma)^{19}O$ was measured with reactor neutrons on targets of ^{18}O-enriched Na_2CO_3, relative to the cross-section for $^{23}Na(n,\gamma)^{24}Na$. Assuming the half-life of ^{19}O to be 27 sec, the following values were found: $\sigma = (1.7 \pm 0.1) \times 10^{-4}$ barn (effective cross-section) $\sigma_0 = (1.6 \pm 0.1) \times 10^{-4}$ barn (thermal cross-section) $I' = (7.4 \pm 0.4) \times 10^{-4}$ barn (excess resonance integral) $I = (8.1 \pm 0.4) \times 10^{-4}$ barn (resonance integral). (auth) (UK)

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Refer also to abstracts 44659, 44727, 44742, 45770, 45837, 45874, 45897, 45899, 45906, 45912, 45914, 45915, 45925, 45930, 45936, 45941, 45942, 46021, 46025, 46059, 46070, 46072, 46075, 46123, 46124, and 46132.

45948 (CEA-N-1390, pp 1-90) INVESTIGATIONS WITH THE VAN DE GRAAFF TANDEM. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French)

Topics covered are: the absolute calibration of the FN 14 (King) tandem; the variations of the K constant of the analyzing magnet (K being defined in the relation between the resonant frequency and the accelerated particle energy); heavy positive ion sources O^{5+}, O^{6+}, Li^{3+}, S^{8+} and heavy negative ion sources C^-, F^-, O^-, Cl^-, S^- using charge exchange; quartet structure in the 2p–1f shells of ^{58}Ni, ^{60}Ni, from (^{16}O, ^{12}C) α transfer reaction by ^{54}Fe, ^{56}Fe, between 48 and 52 MeV; the excitation function of ^{24}Mg levels from the $^{12}C(^{16}O,\alpha)^{24}Mg^*$ reaction between 45 and 56 MeV and deexcitation using $\alpha-\gamma$ coincidence methods; excitation functions and angular distributions in three or four nucleon transfer reactions induced by ^6Li in ^{11}B, ^{12}C, and ^{13}C at energies between 0 and 32 MeV; ^3He, t and α induced transfer reactions; the nuclear structures of ^{107}In, ^{113}In and ^{115}In by (^3He,d) reactions with ^{106}Cd, ^{112}Cd and ^{114}Cd at 18 MeV and (α,t) with ^{114}Cd at 24 MeV; optical model parameters from angular distributions in (t,α) reactions with ^{121}Sb, and ^{123}Sb at 12 MeV; spectroscopic factors concerning the states of the odd Sb isotopes (A = 121 to 129) and the wave functions of the ground states of ^{122}Te and ^{130}Te from (t,α) reactions with the even Te isotopes (A = 122 to 130) at 12 MeV; the 2p–1h components of ^{17}O from the double stripping reaction $^{15}N(^3He,p)$ at 18 MeV; the $^{14}N(\alpha,d)^{16}O$ reaction at 21 MeV; levels from (p,p') scattering by ^{48}Ca, ^{62}Ni and ^{64}Ni at 12 MeV; RPA calculations for even Ni isotopes; deformed states of ^{41}Sc from excitation functions of the $^{40}Ca(p,p')$ reaction; analog states in ^{140}La from excitation functions of $^{139}La(p,p)$ and $^{139}La(p,p')$ between 12 and 18 MeV; analog resonances in deformed nuclei, excitation function of elastic and inelastic proton scattering by the even-even Yb isotopes (A = 170, 172, 174, 176); experimental techniques. (France)

45949 (COO–1746-50) ENERGY DEPENDENCE OF THE REORIENTATION EFFECT AND THE STATIC QUADRUPOLE MOMENT OF THE 0.847 MeV 2^+ STATE IN ^{56}Fe. Thomson, J. A.; Scharenberg, R. P.; Lutz, W. R. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1971. 38p. Dep. NTIS.

The energy dependence of the reorientation effect has been investigated using ^{16}O and ^{32}S ions incident on ^{56}Fe nuclei. The influence of nuclear interference on the reorientation effect was observed before it could be detected on the elastic cross section, and exhibited an angular dependence similar to that expected for the reorientation effect. It was found that an appropriate separation of projectile and target nuclei was given by $2a = R_0(A_1^{\frac{1}{3}} + A_2^{\frac{1}{3}}) + \Delta$ where $R_0 = 1.6$ fm and $\Delta \geq 3.5$ fm. The static quadrupole moment of the 0.847 MeV 2^+ state in ^{56}Fe was measured to be $Q_{22} = -0.23 \pm .03$ b while the rotational value is given by $|Q_R| = 0.276$ b. (auth)

45950 (NP–18811) STUDY OF ISOBARIC ANALOG STATES BETWEEN 4 AND 8 MeV FOR THE REACTION $^{52}Cr(p,p)^{52}Cr$ AND $^{52}Cr(p,p)^{52}Cr$. Garcia, Miguel Balcazar (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Fisica y Matematicas). 1970. 81p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

^{52}Cr was irradiated with protons, and the energy levels of the compound nucleus ^{53}Mn above 7-MeV excitation energy were observed. Excitation functions from 4 to 8 MeV were obtained for the ground state and from 6.1 to 8 MeV for the 2nd, 3rd, 4th, and 5th excited states at an observation angle of 165°. A second detector at 90° was used to obtain data at two angles simultaneously, principally in the lower energy region. The excitation function for the first group of inelastic particles was thus obtained. The results show uncertainties due primarily to the fact that the Coulomb energy displacement intervenes in a very critical form in the energy calculation. A way to eliminate this uncertainty is presented. (J.S.R.)

45951 (UAE-NPL–1019) ENERGY LEVELS OF $^{45}Sc(p,n)^{45}Ti$ REACTION. Iyengar, K. V. K.; Wong, E.; Neilson, G. C. (Alberta Univ., Edmonton. Nuclear Research Centre). Jul 1970. 28p. Dep. NTIS (U. S. Sales Only).

The energy levels of ^{45}Ti excited in the reaction $^{45}Sc(p,n)^{45}Ti$ were investigated by neutron time-of-flight technique. Levels in ^{45}Ti at 1.521, 1.800, 1.880 and 2.020 MeV were observed for the first time through this reaction. Angular distributions of the neutron groups to the ground state and 0.040-, 0.330-, 0.744-, 1.226-, 1.353- and 1.468-MeV levels were measured at a mean proton energy of 5.330 MeV. The neutron distributions to the ground state and 0.040-, 0.330- and 0.744-MeV levels of ^{45}Ti were compared with the predictions from Hauser–Feshbach statistical model, and a spin of $\frac{5}{2}$ was assigned to the 0.744-MeV level. γ-rays from the interaction of protons with scandium were observed using a Ge(Li) detector, and γ-rays of 293, 414, 482, 707, 896, 1186, 1226, 1313, 1353, 1468 and 1484 keV were observed to arise from transitions between levels of ^{45}Ti. The angular distributions of the 293- and 414-keV γ-rays were measured at proton bombarding energies of 3.45 and 3.85 MeV, respectively, and were found to be isotropic. (auth) (Canada)

45952 HIGH-SPIN STATES IN ^{24}Mg. Balamuth, D. P.; Holden, James E.; Noe, John W.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 26: No. 20, 1271-4(17 May 1971).

Angular correlation measurements involving the reaction ^{16}O(^{12}C,α)^{24}Mg* → α + ^{20}Ne*, leaving ^{20}Ne in its first excited state, were used to study several highly excited states in ^{24}Mg. The method was tested using the known 8$^+$ state at 14.14 MeV. The results indicate that the triplet of states at 16.30, 16.55, and 16.84 MeV all have high spin (probably 8, 9, or 10). In the analysis it is assumed that the decay proceeds by the lowest allowed L value. (auth)

45953 LIFETIMES OF SOME LEVELS IN ^{30}P. Bini, M.; Bizzeti, P. G.; Bizzeti-Sona, A. M.; (and others) (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim.; 4A: No. 1, 45-60(1 Jul 1971).

The mean lives of a number of excited states of ^{30}P were measured with a D.S.A. technique. The reaction ^{29}Si(p,γ)^{30}P was used at the resonances E_p = 731, 1506, 1686, 1748 and 1772 keV. The decay of each resonance was checked. For some levels, discrepancies were found with other results. The method for analysis and evaluation with an improved, simple fit of the energy loss formula is described in detail. (auth)

45954 GAMMA DECAY OF THE LOW-ENERGY LEVELS OF ^{49}V. Blasi, P.; Mando, M.; Maurenzig, P. R.; Taccetti, N. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim.; 4A: No. 1, 61-70(1 Jul 1971).

The ^{49}V level scheme was studied by the ^{49}Ti(p,nγ)^{49}V reaction at various bombarding energies between 2 and 4 MeV. Gamma-ray single and coincident spectra were observed; the branching ratios of various levels were measured and information about their spin and parity was deduced. The level scheme is in good agreement with the results of the Coriolis coupling model calculations of Malik and Scholz. Some even-parity levels are present which show the typical pattern of a rotational band based upon the $1d_{\frac{5}{2}}$ hole excitation. (auth)

45955 ENERGY LEVELS IN ^{34}Cl FROM THE ^{33}S(^{3}He,d)^{34}Cl REACTION: A STUDY OF THE $(d_{\frac{3}{2}})^2$ AND THE $d_{\frac{3}{2}}f_{\frac{7}{2}}$ INTERACTIONS. Erskine, J. R. (Argonne National Lab., Ill.); Crozier, D. J.; Schiffer, J. P.; Alford, W. P. Phys. Rev., C; 3: No. 5, 1976-89(May 1971).

The energy levels of ^{34}Cl have been studied with the ^{33}S(^{3}He,d)^{34}Cl reaction induced by the 14-MeV ^{3}He beam of the Argonne tandem Van de Graaff accelerator. An Enge split-pole magnetic spectrograph was used to record the deuteron spectra at scattering angles of 10 to 65° in 5° steps. An overall energy resolution width of 17 keV was achieved. 26 levels up to an excitation energy of 4.6 MeV were observed and their spectroscopic factors were extracted. The results, when combined with previously known spin information, enable us to locate the major components of $(d_{\frac{3}{2}})^2$ and $d_{\frac{3}{2}}f_{\frac{7}{2}}$ configurations. The two-body matrix elements obtained here are compared with other two-body data in nearby nuclei and with calculated matrix elements. (auth)

45956 NUCLEAR STRUCTURE OF ^{43}Sc. III. LIFETIMES. Poirier, C. P. (Aerospace Research Labs. Wright-Patterson Air Force Base, Ohio); Tveter, A.; Manthuruthil, J. C.; (and others). Phys. Rev., C; 3: No. 5, 1939-49(May 1971).

The mean lifetimes of 15 excited states of ^{43}Sc and upper and/or lower bounds for six others have been measured by the Doppler-shift attenuation method. The ^{40}Ca(α,pγ) and ^{42}Ca(p,γ) reactions were used to populate the levels. For the (α,pγ) measurements, γ rays were detected at 90° to the α-particle beam in coincidence with protons detected at +110 and −110°. The ^{43}Sc ions were stopped in thick carbon backings, the stopping power of which is known from previous experimental work. For the (p,γ) measurements, γ rays were detected at 0 and 135° to the proton beam. The ^{43}Sc ions were stopped in the target material. The results yield the following mean lives, in fsec (with the level energies in MeV given in parentheses): 230 ± 70 (0.846), >620 (0.856), 800 ± 300 (0.880), 3100^{+2100}_{-1000} (1.158), 400 ± 190 (1.179), 850 ± 250 (1.336), 240 ± 50 (1.410), 330 ± 100 (1.651), 22 ± 7 (1.810), 300 ± 50 (1.827), 80 ± 50 (1.885), >800 (1.930), 100 ± 20 (1.963), 410 ± 150 (2.094), 260 ± 70 (2.143), 150 ± 50 (2.580), 80 ± 20 (2.986), <5 (3.289), <10 (3.452), <5 (3.807), and <5(4.455). The lifetime results for the 1.158- and 1.652-MeV levels are used to remove ambiguities in the measured mixing ratios. All results are compared with theoretical predictions of Johnstone and co-workers. (auth)

45957 TWO-PARTICLE–TWO-HOLE EXCITATIONS AND INTRINSIC SHAPES OF DEFORMED NUCLEI. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay); Warke, C. S.; Khadkikar, S. B. Phys. Rev., C; 3: No. 5, 1936-9(May 1971).

The contribution of two-particle–two-hole excitations to the Hartree–Fock energy in the ground state of ^{24}Mg favors an axially symmetric prolate shape over the nonaxial shape preferred on the basis of bare Hartree–Fock calculations. The second-order contribution, however, does not affect the prediction of Hartree–Fock calculations of ^{20}Ne and ^{28}Si. (auth)

45958 EXCITATION OF ^{20}Ne BY 180° ELECTRON SCATTERING. Bendel, W. L.; Fagg, L. W.; Numrich, S. K.; Jones, E. C. Jr.; Kaiser, H. F. (Naval Research Lab., Washington, D. C.). Phys. Rev., C; 3: No. 5, 1821-7(May 1971).

States in ^{20}Ne have been studied by 180° inelastic electron scattering with incident energies of 39 and 56 MeV. A large scattering peak is found at each bombarding energy, showing excitation of a 1$^+$, T = 1 state at 11.2 MeV, with transition radius R = 2.53 ± 0.15 fm and radiation width Γ_0 = 11 ± 2 eV. Other levels from 11 to 19 MeV are also excited. (auth)

45959 MEAN LIFETIME OF THE 1.61-MeV LEVEL IN ^{37}Ar. Ragan III, C. E. (North Carolina State Univ., Raleigh. Triangle Universities Nuclear Lab., Durham, N. C.); Mitchell, G. E.; Tilley, D. R.; Gould, C. R.; Roberson, N. R. Phys. Rev., C; 3: No. 5, 2076-8(May 1971).

The mean lifetime of the 1.61-MeV level of ^{37}Ar has been measured by applying the recoil-distance method to the ^{34}S(α,n)^{37}Ar reaction. The mean lifetime was found to be 6.02 ± 0.29 nsec. (auth)

45960 SPECTROSCOPY OF ^{50}V WITH DIRECT (d,t) AND (d,α) REACTIONS. DelVecchio, R.; Daehnick, W. W.; Dittmer, D. L.; Park, Y. S. (Univ. of Pittsburgh). Phys. Rev., C; 3: No. 5, 1989-98(May 1971).

About 50 levels of ^{50}V below 3.2 MeV have been studied with 9- to 15-keV resolution via the ^{51}V(d,t)^{50}V, ^{52}Cr(d,α)^{50}V, and ^{48}Ti(^{3}He,p)^{50}V reactions. Angular distributions were taken (at 16 MeV) for the ^{51}V(d,t) reactions and (at 17 MeV) for ^{52}Cr(d,α)^{50}V · (d,t) and (d,α) l values were extracted by comparison with distorted-wave Born-approximation calculations. For most of the levels seen, direct-reaction selection rules lead to narrow limits for the final-state spins, and in a few cases to unique J$^\pi$ assignments. The spectroscopic information for the lowest levels was compared with shell-model predictions, and qualitative agreement was found. The lowest negative-parity states seen were above 2 MeV. Little 2p strength was found in the pickup experiments, and strong suppression of (d,α) transitions to J$^\pi$ = (even)$^+$ states suggests that the low-lying states of ^{50}V are predominantly of $(f_{\frac{7}{2}})^n$ configuration. However, a comparison with the (d,α) spectrum for the particle-hole conjugate nucleus ^{46}Sc shows that these nuclei are more dissimilar than a simple $(f_{\frac{7}{2}})^n$ model would suggest. (auth)

45961 NUMBER-CONSERVING SHELL-MODEL CALCULATIONS FOR NICKEL AND TIN ISOTOPES. Gambhir, Y. K. (International Centre for Theoretical Physics, Trieste, Italy. Carnegie-Mellon Univ., Pittsburgh); Rimini, A.; Weber, T. Phys. Rev., C; 3: No. 5, 1965-71(May 1971).

The broken-pair approximation (BPA), introduced as a number-conserving approximation to the lowest-seniority shell model (LSSM), is applied to the nickel and tin isotopes. The shell-model interactions used are microscopically derived from the Tabakin potential and the Yale-Shakin reaction matrix or phenomenologically determined (by the Argonne group) through a shell-model-fit procedure. The results are compared with those of standard quasi-particle calculations (QTD) and, when possible, of the exact shell model (ESM) and of the LSSM. It is found that the BPA and the QTD can give essentially different results. Comparison with the LSSM and the ESM indicates that the BPA is a much more reliable approximation than the QTD. (auth)

45962 DECAY OF ^{25}Na. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H. Phys. Rev., C; 3: No. 5, 1957-64(May 1971).

^{25}Na was produced in the ^{23}Na(t,p)^{25}Na reaction and its radiations were investigated by means of Ge(Li), plastic, and NaI(Tl) detectors. From β-γ coincidence experiments the ^{25}Na β-ray branch to the ground state of ^{25}Mg is 62.5 ± 2.0%. Other β- and γ-ray branches were derived from the γ-ray spectrum and are in agreement with previous results. From both singles and γ-γ coincidence measurements a limit of <0.02% (log ft > 6.5) is placed on the β-ray branch to the 2738-keV J$^\pi$ = $\frac{7}{2}^+$ state of ^{25}Mg. Recent shell-model calculations give a good account of the relative experimental β-branching intensities and, in particular, predict that the transition to the 2738-keV state should be very weak. (auth)

45963 YIELDS OF RADIONUCLIDES IN THIN IRON TARGETS BOMBARDED WITH 40-MeV TO 16-GeV ELECTRONS. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Toth, K. S.; Williams, I. R.; Dell, G. F.; Jenkins, T. M. Phys. Rev., C; 3: No. 5, 1955-7(May 1971).

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Yields of several radionuclides in thin iron targets were measured for electron bombarding energies of 40-MeV to 16-GeV. In general the yields appear to approach zero at bombarding energies near threshold energies for nuclide production by nucleon emission from the target nucleus. The effect of bombarding energy on the yield surface for cascade-evaporation reactions was investigated by comparing ratios of yields; the results suggest that except for the slope of the ridge the shape of the yield surface does not vary with energy for bombarding energies above a few hundred MeV. (auth)

45964 RADIATIVE E1 DECAY OF ANALOG STATES IN ^{89}Y. Hughes, T. A. (International Business Machines Scientific Center, Houston, Tex.); Fallieros, S. Phys. Rev., C; 3: No. 5, 1950-5(May 1971).

A study of the dipole spectrum of analog states in ^{89}Y is presented. Both ground-state decays and transitions to the second excited $^3/_2^-$ state are discussed. The angular momentum and parity quantum numbers of the levels under consideration are $^1/_2^+$, $^3/_2^+$, and $^5/_2^+$. As in previous work in even-even nuclei, most of the radiative strength is found concentrated in the high-energy region of the spectrum. (auth)

45965 810.6-863.6-keV $\gamma\gamma$ DIRECTIONAL CORRELATION IN ^{58}Fe. Singhal, N. C. (Vanderbilt Univ., Nashville); Ramayya, A. V.; Hamilton, J. H.; Raman, S. Z. Phys.; 245: No. 1, 50-4(1971).

The 810.6-863.6 keV $\gamma\gamma$-directional correlation has been measured with an NaI(Tl)-Ge(Li) detector system. The NaI window was set on the 810.6 + 863.6 keV composite peak. From the (810.6 NaI gate) (863.6 Ge spectrum) data at 90°, 135°, and 180°, $A_2 = +0.51 \pm 0.03$ and $A_4 = +0.09 \pm 0.04$ were deduced. These results disagree with the values previously obtained from ^{58}Co decay (with NaI-NaI detector systems) but agree with the values from $\gamma\gamma(\theta)$ studies following thermal neutron capture by ^{57}Fe. (auth)

45966 MEAN LIFETIME OF THE 720-keV LEVEL OF ^{45}Sc. Rust, N. J. A.; Koen, J. W.; Mouton, W. L. (Univ. of Stellenbosch, S. Afr.). Z. Phys.; 245: No. 1, 45-9(1971).

The lifetime of the fourth excited state of ^{45}Sc, at an energy of 720 keV, was determined in a nuclear resonant scattering experiment. Gamma rays of the desired energy for the excitation of this level were obtained by Compton scattering of the 1173 and 1332 keV photons from a 4300 Ci radioactive ^{60}Co source. A value of (5.6 ± 1.2) MeV was found for the radiation width of the level, assuming a value of $^5/_2$ for its spin. The corresponding mean lifetime is (0.12) ps. An attempt was made to determine the spin of the level by means of angular distribution measurements. (auth)

45967 INTERACTIONS OF FAST NEUTRONS WITH ^{45}Sc. Barnard, E.; de Villiers, J. A. M.; Reitmann, D.; Tepel, J. W. (Atomic Energy Board, Pelindaba, S. Afr.). Z. Phys.; 245: No. 1, 36-44(1971).

Interactions between Sc and neutrons with energies between 0.2 and 1.4 MeV were studied by time-of-flight methods. Total cross sections, elastic scattering, angular distributions and excitation functions for inelastic scattering were measured and the results are compared with theory. (auth)

45968 EXCITATION FUNCTIONS FOR THE DEUTERON-INDUCED REACTIONS ON ^{63}Cu AND ^{65}Cu. Okamura, H.; Tamagawa, S. (Osaka Univ.). Nucl. Phys.; A169: No. 2, 401-6(1971).

Excitation curves for the deuteron-induced reactions on ^{63}Cu and ^{65}Cu were measured up to 11 MeV bombarding energy and the observed reactions were ^{63}Cu(d,p)^{64}Cu, ^{63}Cu(d,2n)^{63}Zn, ^{65}Cu(d,p)^{66}Cu and ^{65}Cu(d,2n)^{65}Zn. The excitation curve for the ^{65}Cu(d,p)^{66}Cu reaction as obtained in the present work was quite different from previous work, while the cross section for the ^{63}Cu(d,2n)^{63}Zn reaction was found to be much smaller than the cross section for the ^{65}Cu(d,2n)^{65}Zn reaction in agreement with the earlier investigations. All the excitation curves were well reproduced by a simple calculation in which common parameter values were used for both reactions. The emission rate of the ^{66}Cu 1.04 MeV γ-ray was determined to be (11.9 ± 0.9)% per disintegration. (auth)

45969 STUDY OF THE ^{86}Sr(τ,α)^{85}Sr REACTION. Ivascu, M. (State Univ., Utrecht); Popescu, D.; Bucurescu, D.; Spilling, P. Nucl. Phys.; A169: No. 2, 429-36(1971).

The structure of the ^{85}Sr nucleus has been investigated by measuring the angular distributions of α-particles from the ^{86}Sr(τ,α)^{85}Sr reaction at a bombarding energy of 17.5 MeV, with a 90 cm split-pole magnetic spectrograph. Angular distributions from 6 to 80° have been obtained for the ground state and levels with excitation energies of 0.23, 0.74, 0.90, 1.14, 1.23, 1.62, 1.96 and 2.14 MeV. A DWBA analysis provides l-values and spectroscopic factors for all but one of these levels. (auth)

45970 MEASUREMENTS OF SPALLATION CROSS SECTIONS FOR 590 MeV PROTONS ON THIN TARGETS OF COPPER, NICKEL, IRON, AND ALUMINUM. Cline, J. E.; Nieschmidt, E. B. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys.; A169: No. 2, 437-48(1971).

Yields have been measured of approximately 50 spallation products from 590 MeV protons on thin natural targets of copper, nickel, iron and aluminum. Non-destructive γ-ray spectrographic techniques have been used in the analyses allowing yield determinations for the short-lived (i.e., $T_{\frac{1}{2}} \geq$ 10 s) spallation products. Measured yields are compared to yields calculated using the current formulas. (auth)

45971 BRUECKNER-HARTREE-FOCK CALCULATIONS OF SPHERICAL NUCLEI IN A HARMONIC-OSCILLATOR BASIS. III. RENORMALIZED CALCULATIONS USING THE REID POTENTIAL. Davies, K. T. R. (Oak Ridge National Lab., Tenn.); McCarthy, R. J. Phys. Rev., C; 4: No. 1, 81-97(Jul 1971).

A G matrix derived from the Reid soft-core potential is used in a series of Brueckner-Hartree-Fock calculations of spherical nuclei. The G matrix is calculated using an intermediate-state spectrum and Pauli operator appropriate to pure oscillator orbitals, with options to shift the entire spectrum or the low-lying levels from unperturbed oscillator energies. The Pauli operator takes into account the filling of different neutron and proton subshells in $N \neq Z$ nuclei. Self-consistent occupation probabilities are included in the calculations, and results are presented for ^{16}O, ^{40}Ca, ^{48}Ca, and ^{208}Pb. Various systematics and convergences are studied. Good results can be obtained for the binding energies, but the experimental binding energy and charge radius cannot be fitted simultaneously. It is shown that renormalization with occupation probabilities is crucial for calculating a reasonable single-particle spectrum. The difficulty of comparing single-particle energies with experiment is discussed with particular emphasis on heavy and superheavy nuclei. The nuclei ^{298}114 and ^{310}126 are calculated for a simple force. (auth)

45972 CROSS-SECTION MEASUREMENTS FOR THE TRANSFER REACTIONS (^{14}N,^{13}N) AND (^{19}F,^{18}F) INDUCED ON ^{19}F, ^{23}Na, AND ^{51}V. Gaedke, R. M. (Trinity Univ., San Antonio. Oak Ridge National Lab., Tenn.); Toth, K. S.; Williams, I. R. Phys. Rev., C; 4: No. 1, 98-104(Jul 1971).

Thick targets of ^{19}F, ^{23}Na, and ^{51}V were bombarded with ^{14}N and ^{19}F ions accelerated in the Oak Ridge tandem Van de Graaff accelerator. Cross sections were measured for the neutron transfer reactions ^{19}F(^{14}N,^{15}N)^{18}F, ^{19}F(^{19}F,^{18}F)^{20}F, ^{23}Na(^{19}F,^{18}F)^{24}Na, ^{51}V(^{14}N,^{13}N)^{52}V, and ^{51}V(^{19}F,^{18}F)^{52}V at energies close to the Coulomb barriers for the various target and projectile combinations. The data were analyzed by the use of the tunneling theory of Breit et al. The theory was found to account for the shapes of the excitation functions of the first three reactions listed above. The excitation functions for the two reactions with ^{51}V as the target nucleus were found to have slopes that were steeper than that predicted by the tunneling theory. This is thought to be an indication that, even at energies below the Coulomb barrier, excited states in ^{52}V are populated in the transfer process. By assuming that the neutron reduced width in ^{52}V is the same in both the ^{19}F- and ^{14}N-induced reactions, a reduced-width ratio was extracted for the transferred neutron in ^{19}F to that in ^{14}N. The ratio was found to be ~2.0 as compared with values of ~3.7 extracted earlier from low-energy cross-section data for (^{19}F,^{18}F) and (^{14}N,^{13}N) reactions on targets of ^{10}B and ^{14}N. If the ±30% error limits on the experimental cross sections are taken into account, the value of 2 is not in disagreement with the earlier determined ratios of 3.7. The difference presumably arises because transfers to the ground states in ^{11}B and ^{15}N are predominant at low bombarding energies. Since this is apparently not so for the reactions with ^{51}V (see above), the ^{19}F reaction may populate states in ^{52}V different from those which the ^{14}N reaction would populate; the reduced-width ratio would then not be the same as that extracted from the data with ^{10}B and ^{14}N targets. (auth)

45973 LEVEL STRUCTURE OF ^{42}Ca BY ^{41}K(^{3}He,d)^{42}Ca AND ^{39}K(α,p)^{42}Ca REACTIONS AT 10 MeV. Pellegrini, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Gentilin, F.; Filosofo, I. Phys. Rev., C; 4: No. 1, 112-25(July 1971).

The level structure of ^{42}Ca, below 6 MeV in excitation, was studied by ^{41}K(^{3}He,d)^{42}Ca and ^{39}K(α,p)^{42}Ca reactions at 10 MeV bombarding energy. Particle detection was achieved with a surface-barrier detector telescope. Comparison of 12 measured (^{3}He,d) angular distributions with zero-range distorted-wave Born-approximation calculations indicates a predominance of l = 3 and l = 1 transfers, and gives information about states arising from the

$(1f_{\frac{7}{2}}1d_{\frac{3}{2}}^{-1})$ and $(2p_{\frac{3}{2}}1d_{\frac{3}{2}}^{-1})$ configurations. Shell-model calculations were performed to investigate the level scheme in ^{42}Ca arising from the $(1f_{\frac{7}{2}}^{3}1d_{\frac{3}{2}}^{-1})_{JT}$ configuration by using four different sets of effective interaction parameters between the $1f_{\frac{7}{2}}$ particle and $1d_{\frac{3}{2}}$ hole. The resulting wave functions were used to calculate spectroscopic factors, which are compared with the experimental ones. The measured (α,p) angular distributions analyzed with Hauser–Feshbach calculations indicate a predominance of compound-nucleus mechanism for this reaction. Good agreement is found between the integrated experimental and theoretical cross sections. (auth)

45974 NOTE ON THE RADIAL SHAPE OF ISOSPIN POTENTIAL. Sengupta, H. M. (Dacca Univ., Pakistan); Husain, D.; Rahman, M.; Musa, M. Progr. Theor. Phys. (Kyoto); 45: No. 3, 971-3(Mar 1971).

In an attempt to determine the radial shape of the isospin potential, angular distributions for the (p,n) reaction with ^{45}Sc, ^{46,47,48,49,50}Ti, ^{51}V, ^{52}Cr, ^{55}Mn, ^{56}Fe, and ^{59}Co at 15.2 and 18.5 MeV were analyzed with the optical model. The model parameters found and some of the calculated angular distributions are given. The results indicate that the choice of form factor is probably not important. (R.W.R.)

45975 STUDY OF THE REACTION ^{20}Ne(h,h$_{0\ 1\ 2}$)^{20}Ne AT 17.83 MeV. Kemper, K. W.; Haynes, D. S.; Fletcher, N. R. (Florida State Univ., Tallahassee). Phys. Rev., C; 4: No. 1, 108-12(Jul 1971).

Angular distributions for the scattering of helions to the 0^+, 2^+, and 4^+ members of the ground-state rotational band of ^{20}Ne were measured at 17.83 MeV. An optical-model analysis of the elastic scattering was performed as well as a coupled-channels analysis of the inelastic data. Good agreement between the coupled-channels calculations and the experimental data is found for the 2^+ data, with β_2 in the range 0.42 to 0.48. These calculations give a poor description of the 4^+ data, but from the shape of the angular distributions an upper limit of 0.05 for β_4 is assigned. (auth)

45976 STRONG L = 0(t,p) TRANSITIONS IN THE EVEN ISOTOPES OF Ti, Cr, AND Fe. Casten, R. F.; Flynn, E. R.; Hansen, Ole; Mulligan, T. J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 130-7(Jul 1971).

Absolute differential cross sections for strong L = 0 (t,p) transitions on targets of ^{46,48,50}Ti, ^{50,52,54}Cr, and ^{54,56,58}Fe were measured. The bombarding energy was 13 MeV, and reaction angles of 12.5 and 20° were used. The data are compared with model predictions, with special emphasis on the pairing–vibrational model with isospin. The latter model correctly predicts the dependence on neutron number of the (t,p) cross sections, but fails, as do all other models, to predict the steady cross-section decrease with increasing Z. It is suggested that the latter effect is caused by a slow change in the ground-state correlations. (auth)

45977 DIFFERENTIAL RECOIL STUDY OF THE ^{25}Mg(p,2p)^{24}Na REACTION. Kiely, F. Michael; Caretto, Albert A. Jr. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., C; 4: No. 1, 137-44(Jul 1971).

Differential recoil spectra for the ^{25}Mg(p,2p)^{24}Na reaction were measured radiochemically at recoil angles of 90 and 60° for an incident energy of 300 MeV and at a recoil angle of 90° for 100 MeV bombarding energy. All the spectra display two peaks. The position of the lower-energy peak seems to remain unchanged with a shift in incident energy, while the higher-energy peak shifts to higher kinetic energies with an increase in bombarding energy. The results are compared with the spectra calculated from a plane-wave impulse-approximation calculation which assumes that only the $1d_{\frac{5}{2}}$ protons in ^{25}Mg are available for interaction. Limited agreement is obtained. (auth)

45978 NEUTRON INDUCED REACTIONS IN SILICON SEMICONDUCTOR DETECTORS. Mingay, D. W.; Sellschop, J. P. F.; Johnson, P. M. (Univ. of Witwatersrand, Johannesburg). Nucl. Instrum. Methods; 94: No. 3, 497-507(1971).

Total cross sections for the ^{28}Si(n,α)^{25}Mg and ^{28}Si(n,p)^{28}Al reactions were measured for neutron energies between 12.80 and 16.24 MeV, for the ground and first four resolved excited states of ^{25}Mg and the unresolved pairs consisting of the ground and first excited and second and third excited states of ^{28}Al. The neutron energy resolution was less than 30 keV. The active volume of silicon semiconductor detectors was used both as target and detector. (auth)

45979 β^+ DECAY OF ^{25}Al. Jundt, F., Aslanides, E.; Fride, B.; Gallmann, A. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). Nucl. Phys.; A170: No. 1, 12-16 (1971). (In French).

The positon decay of ^{25}Al has been investigated via the ^{24}Mg(d,n) reaction at E_d = 4 MeV. The measured half-life $T_{\frac{1}{2}}$ = 7.23 ± 0.02 s for the ^{25}Al decay is in good agreement with the reported average value. The measured branching of the transition feeding the 1611.5 ± 0.2 keV third excited state of ^{25}Mg, (0.84 ± 0.07%), which implies log ft = 4.32 ± 0.04, is in good agreement with collective model predictions. (auth)

45980 LOW-INTENSITY TRANSITIONS IN THE DECAY OF ^{75}Se. Pratt, William W. (Pennsylvania State Univ., University Park). Nucl. Phys.; A170: No. 1, 223-4(1971).

A study of the decay of ^{75}Se has revealed the presence of γ-rays with energies of 821.7 ± 0.2 keV and 469.4 ± 1.0 keV, which are attributed to the de-excitation of ^{75}As states previously reported at these energies. The γ-ray intensities (relative to I_γ[265 keV] = 100) and the electron capture log ft values are: for the 821.7 keV state $I_\gamma = (2.16 \pm 0.10) \times 10^{-4}$, log ft = 9.5; and for the 469.4 keV state $I_\gamma = (5.4 \pm 1.8) \times 10^{-4}$, log ft = 8.9. These results are consistent with current spin and parity assignments to the nuclear states involved. (auth)

45981 ABSOLUTE NEUTRON CROSS SECTIONS FOR THE PRODUCTION OF THE ^{24}Na ISOMER FROM MAGNESIUM AND ALUMINUM. Salaita, G. N. (Southern Methodist Univ., Dallas). Nucl. Phys.; A170: No. 1, 193-8(1971).

The cross sections for the ^{24}Mg(n,p)^{24m}Na and ^{27}Al(n,α)^{24m}Na reactions were measured using the cyclic activation technique and a high-energy resolution Ge(Li) detector. The experimentally determined values of production cross sections are σ[^{24}Mg(n,p)^{24m}Na] = 138 ± 14 mb and σ[^{27}Al(n,α)^{24m}Na] = 65 ± 6 mb. (auth)

45982 STRIPPING ANALYSIS OF THE ^{87}Rb(d,p)^{88}Rb REACTION. Rapaport, J. (Ohio Univ., Athens); Robinson, R. L.; Ford, J. L. C. Jr.; Rao, M. N. Nucl. Phys.; A170: No. 1, 199-208(1971).

The ^{87}Rb(d,p)^{88}Rb reaction was studied at an incident deuteron energy of 11.0 MeV. A ground state Q-value of 3.858 ± 0.015 MeV was measured for this reaction. Proton spectra were obtained every 5° at lab angles between 20° and 120° for groups up to 2.5 MeV excitation energy. A distorted-wave analysis was carried out to obtain l_n values and spectroscopic strengths. (auth)

45983 ELECTROEXCITATION OF ^{32}S IN THE REGION OF THE DIPOLE RESONANCE. Bely, Yu. I. (Moscow State Univ.).; Kabachnik, N. M.; Neudatchin, V. G.; (and others). Nucl. Phys.; A170: No. 1, 141-52(1971).

The C1 + E1 and M2 form factors for inelastic scattering of high-energy electrons by ^{32}S in the region of the dipole giant resonance have been calculated. The used wave functions of excited states were obtained in terms of a microscopic "particle-hole" approach of the shell model taking into account the configurational splitting and coupling of the particle-hole excitations to one- and two-phonon states. A reasonable fit with the experimental data of Afanasyev and coworkers for the ^{32}S excitation curve at different momentum transfers $q \leqq 1$ fm^{-1} was obtained though the agreement of the γ-quanta absorption cross sections and the (γ,n) reaction with the experiment is not satisfactory. It is emphasized that the cross sections (γ,γ), (γ,p_0) and (p,γ_0), the photonucleon spectra and the transverse electron scattering form factors are particularly sensitive to the configurational composition of wave functions in different regions of the ^{32}S excitation curve. (auth)

45984 BETA DECAY OF ^{25}Al AND ^{37}K. Moss, C. E.; Detraz, C.; Zaidins, C. S. (Univ. of Colorado, Boulder). Nucl. Phys.; A170: No. 1, 111-14(1971).

New branches in the β^+ decay of ^{25}Al and ^{37}K have been observed and their log ft values determined. Upper limits for the branching ratios are reported for unobserved branches. A K-forbidden branch was observed in the decay of ^{25}Al which indicates band mixing in the low-lying levels of A = 25 nuclei. (auth)

45985 ANALOGUE STATES EXCITED IN THE REACTION ^{56}Fe(p,γ)^{57}Co. Leslie, J. R.; McLatchie, W.; Monahan, C. F.; Thrasher, J. K. (Queen's Univ., Kingston, Ont.). Nucl. Phys.; A170: No. 1, 115-28(1971).

Resonances in the reaction ^{56}Fe(p,γ)^{57}Co at $E_p \approx 1250$ keV and $E_p \approx 1650$ keV have been studied and identified as split analogs of states of ^{57}Fe. Gamma-ray angular distributions have been used to assign resonance spins, decay schemes have been constructed, and in most cases the resonance strengths have been determined. Spin assignments (E_p(keV); J) based on this work are: (1247; $\frac{3}{2}$), (1262; $\frac{1}{2}$, $\frac{3}{2}$), (1267; $\frac{3}{2}$), (1623, $\frac{3}{2}$, $\frac{5}{2}$), (1637; $\frac{1}{2}$, $\frac{3}{2}$), (1646; $\frac{3}{2}$) and (1652; $\frac{3}{2}$). The properties of these analog resonances appear to be similar to those observed in previous investigations of the region A ≈ 50. (auth)

45986 ORIENTATION OF THE RESIDUAL NUCLEUS OF THE REACTION ^{56}Fe(d,p)^{57}Fe*(14 keV)^{57}Fe. Bueche, G.; Appel,

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H.; Renz, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A170: No. 1, 55-64(1971).

Protons from the stripping reaction $^{56}Fe(d,p)^{57}Fe^*$ were observed in coincidence with the two hyperfine transitions ($J = 3/2^-$, $m = \pm 3/2) \rightarrow (1/2^-, \pm 1/2)$ of the 14 keV radiation in ^{57}Fe. The deuteron energy was $E_d = 5.5$ MeV. Moessbauer techniques have been used for detection of the hyperfine transitions. Their relative difference provides information on the orientation of the residual nucleus. The accuracy of the result allows essentially a discussion of the sign. Under certain assumptions, however, the result is related to the polarization of the residual nuclear state $J = 3/2^-$ in ^{57}Fe. Special Moessbauer techniques are described and possible disturbances of the oriented recoiling nucleus are discussed. (auth)

45987 ELECTROMAGNETIC TRANSITION RATES IN ^{60}Ni. Moazed, Cyrus; Becker, T.; Assimakopoulos, P. A.; Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A169: No. 3, 651-69(1971).

The lifetimes of fourteen states in ^{60}Ni, ranging in excitation energy between 3.0 and 4.3 MeV, were measured through the Doppler-shift attenuation method. In addition a lower limit was set for the lifetime of the 2626.2 keV 3_1^+ level. The states were excited through the $^{60}Ni(p,p'\gamma)$ reaction with 7 MeV protons. Singles γ-ray spectra were obtained with a 55 cm^3 Ge(Li) detector at $\theta_\gamma = 0°$, 90°, and 160°. Since the recoil direction of the $^{60}Ni^*$ nuclei was undefined in these measurements, an averaging of the attenuation factor was performed and the influence of this averaging on the error limits was explored. The averaged attenuation factor was also calibrated with respect to known lifetimes in ^{58}Ni. With the help of recent information on electromagnetic decay properties in ^{60}Ni, transition strengths were calculated for the levels considered in this experiment. (auth)

45988 ENERGY DEPENDENCE OF PROTON ELASTIC SCATTERING CROSS SECTIONS FROM Al AND Si. Sandhu, H. S. (San Fernando Valley State Coll., Northridge, Calif.); Cameron, J. M.; McGill, W. F. Nucl. Phys.; A169: No. 3, 600-8(1971).

The differential cross sections for the elastic scattering for protons by aluminium at 22.2, 24.5, 34.1, 40.0, and 46.0 MeV, and by silicon at 24.5, 30.0, 34.1, 40.0, and 46.0 MeV were measured. These data together with the existing data at 17.0 and 61.2 MeV for aluminum and 28.0 and 30.3 MeV for silicon were analyzed using a diffuse-surface optical model of the nucleus. Both the surface and volume absorption terms were required in the imaginary part of the potential. A set of average geometrical parameters was first determined, and the geometrical parameters were held fixed in the subsequent analysis in order to investigate the energy-dependent behavior of the dynamical parameters. The strength of the real central potential was found to decrease with the increasing energy of the incident proton, and the energy dependence can be represented by $dV/dE \approx -0.30$. (auth)

45989 HIGH-RESOLUTION INVESTIGATION OF THE $^{35}Cl(d,p)^{36}Cl$ REACTION. Decowski, P. (State Univ., Utrecht). Nucl. Phys.; A169: No. 3, 513-20(1971).

The angular distributions of 15 proton groups from the $^{35}Cl(d,p)$-^{36}Cl reaction have been measured with a split-pole magnetic spectrograph at $E_d = 7$ MeV. The ^{36}Cl doublet at 1.95 MeV could be resolved in the angular distribution measurements. A DWBA analysis yields l-values and spectroscopic factors. (auth)

45990 β-DECAY OF A DEFORMED DOUBLY ODD NUCLEUS. Yap, C. T.; Tee, C. S. (Univ. of Singapore). Nucl. Phys.; A169: No. 3, 609-16(1971).

Contributions to the Fermi matrix elements for the $\Delta T = -1\beta^-$ transition of ^{24}Na are calculated. In addition to the Coulomb potential, the charge asymmetric components of the nuclear force in the OBEP model are considered. The CVC theory is assumed and the collective model with Nilsson's wave functions is adopted. The theoretical values of the Fermi matrix elements are then deduced. It is shown that the theoretical estimates agree very well with the experimental values. (auth)

45991 MEASUREMENTS OF THE CROSS SECTIONS FOR FORMATION OF COMPOUND NUCLEI IN HEAVY-ION REACTIONS. Kowalsky, L.; Miller, J. M.; D'Auria, J.; Jodogne, J. C. (Columbia Univ., New York). pp VIII.41-6 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Mica detectors afford a possible method of measuring the compound-nucleus part of the reaction cross section in some of the nuclear reactions induced by heavy ions. The $^{20}Ne + ^{27}Al$ and $^{16}O + ^{27}Al$ reactions were studied with incident energies (lab.) of 50 to 200 MeV. The cross section decreases when the energy increases beyond 100 MeV. This behavior seems to put an upper limit to the angular momentum above which the compound-nucleus is not formed. (auth) (France)

45992 EFFECTS OF ISOSPIN ON STATISTICAL NUCLEAR DECAY. Lu, C. C. (Univ. of Rochester, N. Y.); Huizenga, J. R.; Stephan, C. J.; Gorski, A. J. Nucl. Phys.; A164: 225-45 (1971).

Measurements of the cross sections and energy spectra of protons and α-particles emitted from the reactions $^{62}Ni + p$ and $^{59}Co + \alpha$ were made to determine the extent to which isobaric spin is a good quantum number in the intermediate composite system ^{63}Cu at an excitation energy of 18.9 MeV. The composite system ^{60}Ni, formed by the reactions $^{59}Co + p$ and $^{56}Fe + \alpha$, was investigated also in a similar study at an excitation energy of 22.3 MeV. The experimental ratio, $\sigma(\alpha,\alpha')\sigma(p,p')/\sigma(\alpha,p)\sigma(p,\alpha)$, was found to be 2.1 for the ^{63}Cu system and 1.6 for the ^{60}Ni system. Both values of this ratio exceed considerably the theoretical values of approximately unity predicted by the Bohr independence hypothesis and the statistical model of compound nuclear decay including angular momentum. The deviations in the above experimental ratios from the compound nuclear predictions are explained by an isobaric spin selection rule which causes the $T_>$ composite systems to decay preferentially by proton emission. At least 80% of the $T_>$ channels of the composite system ^{63}Cu decay before $T_>$ ceases to be a good quantum number. Although the $T_>$ composite systems retain isospin preference by enhanced proton decay, these protons have evaporation type spectra and angular distributions characteristic of compound nuclear reactions. (auth)

45993 ELECTROMAGNETIC PROPERTIES OF THE FIRST EXCITED STATES OF $^{58\ 60\ 62}Ni$. Gunye, M. R. (Tata Inst. of Fundamental Research, Bombay); Khadkikar, S. B. Nucl. Phys.; A165: 508-12(1971).

The static electric quadrupole and magnetic dipole moments of the first excited 2^+ states of $^{58,60,62}Ni$ are calculated with the projected Hartree–Fock–Bogoliubov (HFB) wave functions. All the nucleons in these nuclei are explicitly taken into account with proton charge $e_p = e$ and neutron charge $e_n = 0$. The reduced transition probabilities $B(E2; 2^+ \rightarrow 0^+)$ are also calculated. The results obtained from the prolate HFB solutions are in fair agreement with the available experimental data. (auth)

45994 OBSERVATION OF WEAK β-DECAY BRANCHES OF ^{77}As. Ardisson, G.; Marsol, C. (Faculte des Sciences, Nice). Can. J. Phys.; 49: 1731-7(1 Jul 1971). (In French).

The decay of ^{77}As was reinvestigated by means of a Ge(Li) detector. $\gamma-\gamma$ coincidences and sum coincidence spectra were also measured with a Ge(Li)–NaI(Tl) assembly. Five new gamma rays are observed at 62.2, 82.0, 139.2, 200.6, and 439.7 keV, which are situated in a revised level scheme of ^{77}Se. An anomalous $5/2^+$ level of 301 keV, seen in $^{76}Se(d,p)^{77}Se$ experiments, is suggested to be fed in the decay of ^{77}As, with a branching ratio of 0.014%. The 440 keV $(5/2^-)$ collective level is also fed by 0.001% of the decays. (auth) (Canada)

45995 CHARGE RADII OF $^{20,22}Ne$ DETERMINED FROM ELASTIC ELECTRON SCATTERING. Moreira, J. R.; Singhal, R. P.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Can. J. Phys.; 49: No. 11, 1434-6(1 Jun 1971).

The charge radii of $^{20,22}Ne$ were measured by elastic scattering of electrons. The data were analyzed in the first Born approximation as well as with a phase shift analysis. The results obtained are $R(^{22}Ne)/R(^{20}Ne) = 0.976 \pm 0.010$. This anomaly is shown to be consistent with ground state deformations in $^{20,22}Ne$. (auth) (Canada)

45996 STUDY OF THE REACTION $^{39}K(p,\gamma)^{40}Ca$ IN THE ENERGY RANGE $E_p = 2.6$ TO 2.8 MeV. Dalmas, J.; Bertault, D.; Vidal, M.; Walter, P.; Petit, G. Y. (Bordeaux Univ., Gradignan, France). J. Phys. (Paris); 32: No. 2-3, 107-11 (Feb-Mar 1971). (In French).

The excitation function of the $^{39}K(p,\gamma)^{40}Ca$ reaction was studied for the proton energy range $E_p = 2.6-2.8$ MeV. The energies and resonance strength values of resonances observed therein were determined. The γ ray de-excitation of these resonances and energies of certain high energy levels and their modes of decay were studied with a 40 cm^3 Ge(Li) detector. (auth) (France)

45997 ^{56}Co DECAY. Genest, Anne-Marie (Univ., Nice). Compt. Rend., Ser. B; 272: No. 14, 863-6(5 Apr 1971). (In French).

The gamma spectrum of ^{56}Co was studied using a coaxial Ge detector. More than ten new gamma transitions were established.

A level scheme is proposed for ^{56}Fe; it involves, for the first time, the 3 605.0 and 3 120.3 keV levels which have only been observed previously with nuclear reactions. (France)

45998 EXCITATION FUNCTION OF THE ^{59}Co(n,p)^{59}Fe REACTION AND THE PRODUCTION OF CARRIER-FREE ^{59}Fe. Krivan, V.; Muenzel, H. (Nuclear Research Centre, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 33: 1233-9(May 1971).

The production of carrier-free ^{59}Fe by the ^{59}Co(n,p)^{59}Fe reaction was investigated. Fast neutrons were produced by bombarding a thick beryllium target with deuterons of about 52 MeV. For the separation of the carrier-free ^{59}Fe from the cobalt matrix the thenoyltrifluoracetone (TTA) solvent extraction method was used. About 0.2 μCi of ^{59}Fe was produced within 1 hr of the irradiation of 1 g cobalt at 1 μA deuteron current. With the help of an empirical method an excitation function for the ^{59}Co(n,p)^{59}Fe reaction was obtained. This method was based on the dependence of certain characteristic data of the excitation function for a given type of reaction, such as the height and position of maxima and the FWHM (full width of curve at half maximum), on the atomic number of the target. The agreement between the activities calculated using this excitation function and the experimental results was good. (auth) (UK)

45999 RADIATIVE WIDTH OF THE 6^+ LEVEL IN ^{20}Ne AT 8.78 MeV. Rogers, D. W. O. (Univ. of Toronto); Aitken, J. H.; Litherland, A. E.; Dixon, W. R.; Storey, R S. Can. J. Phys.; 49: No. 11, 1397-1400(1 Jun 1971).

The radiative width of the 6^+ resonance at E_α = 5.06 MeV in the ^{16}O(α,γ)^{20}Ne reaction was measured to be $\omega\gamma$ = 1.30 ± 0.20 eV corresponding to a transition strength of 20 ± 3 W.u. for the 6^+ to 4^+ transition in ^{20}Ne. Comparison is made to rotational and shell model predictions. (auth) (Canada)

46000 FURTHER ACTIVATION THERMAL NEUTRON CAPTURE CROSS SECTIONS AND RESONANCE INTEGRALS. Ryves, T. B. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 25: 129-31(Mar 1971).

Relevant experimental details are given. Results are tabulated for 2200 m/s neutron capture cross sections and activation resonance integrals for ^{63}Ga, ^{71}Ga, ^{75}As, ^{89}Y, ^{93}Nb, ^{107}Ag, ^{139}La, ^{151}Eu, ^{196}Pt, and ^{198}Pt. All refer to the total production of the radioactive product nucleus in its ground state, both by direct formation or via isomeric transitions, except for ^{94m}Nb, ^{110m}Ag and ^{152m}Eu. Comparison is made with other published values. (UK)

46001 MEASUREMENT OF THE RADIATIVE WIDTH OF THE 6^+, 8.79 MeV LEVEL OF ^{20}Ne. Diamond, W. T.; Alexander, T. K.; Haeusser, O. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 49: 1589-92(15 Jun 1971). (AECL-3869).

Using the ^{4}He(^{16}O,γ)^{20}Ne reaction, $\omega\gamma$ = 1.42 ± 0.17 eV was obtained for the 6^+, 8.79 MeV level of ^{20}Ne. The experimental E2 transition probabilities in the ground state band of ^{20}Ne favor a microscopic model over a simple rotational description. (auth) (Canada)

46002 INELASTIC NEUTRON SCATTERING WITH FISSION NEUTRONS. Nichol, L.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: No. 11, 1461-8(1 Jun 1971).

A detailed investigation was conducted of the usefulness of fission-spectrum neutrons for inelastic neutron scattering studies. A Ge(Li)–NaI(Tl) annular pair spectrometer was employed in conjunction with a versatile in-core irradiation facility to conduct this evaluation. The Doppler broadening and shift which were observed are quantitatively described through the use of a simple model developed for the system. The effectiveness of neutron filters for the reduction of capture reactions which normally produce unwanted background is also discussed. Results indicate that gamma-ray deexcitation, following neutron inelastic scattering, can be readily identified and quantitatively evaluated. During the course of this study resonant neutron capture in the 35 keV resonance of ^{28}Al was observed thus indicating the feasibility of investigation of this type of reaction. Lifetime results for levels in ^{19}F were obtained using a Doppler attenuation method and a possible discrepancy in (dE/dx) values was indicated. (auth) (Canada)

46003 SIZE PARAMETER, NUCLEAR STRUCTURE, AND CHARGE ASYMMETRY. Tee, C. S.; Yap, C. T. (Univ. of Singapore). Nucl. Phys.; A170: No. 2, 445-8(1971).

By explicit calculation it is shown that the theoretical values of nuclear matrix elements of $\Delta T = \pm 1$ Fermi transitions are not sensitive to the size parameter but are very much dependent on the nuclear structure adopted. (auth)

46004 NUCLEAR NEUTRON–PROTON rms RADIUS DIFFERENCE. Lee, H. C.; Cusson, R. Y. (Chalk River Nuclear Labs., Ont.). Nucl. Phys.; A170: No. 2, 439-44(1971).

The Hartree–Fock method is used to calculate the n–p rms radius differences for eight nuclei from ^{48}Ca to ^{120}Sn. These values are compared with experiment and with those predicted from Coulomb displacement energies. The comparison is discussed. (auth)

46005 LEVEL STRUCTURE OF ^{58}Co VIA ^{55}Mn(^{4}He,nγ) PROMPT γ-RAY SPECTROMETERY. Xenoulis, Alexander C.; Sarantites, D. G. (Washington Univ., St. Louis). Contracts AT(11-1)-1530; AT(11-1)-1760. Nucl. Phys.; A170: No. 2, 369-94(1971).

The level structure of ^{58}Co was investigated in some detail via prompt γ-ray energy and intensity measurements utilizing a NaI(Tl)–Ge(Li) anti-Compton spectrometer via the ^{55}Mn(^{4}He,nγ) reaction with ^{4}He^{++} energies in the range 7.5–12.5 MeV. Many of the γ-rays associated with levels in ^{58}Co were identified with the (^{4}He,nγ) reaction by means of nγ coincidence experiments employing an NE 213 scintillator as the fast-neutron detector and a 29 cm^3 Ge(Li) γ-ray detector. Characterization of many levels in ^{58}Co was achieved from $\gamma\gamma$ coincidence relationships established in on-beam $\gamma\gamma$ coincidence measurements in the ^{55}Mn(^{4}He,nγ) reaction at 8.00 and 12.50 MeV of bombarding energy employing a NaI(Tl) and a Ge(Li) detector. It was possible to observe the population of 28 excited states of ^{58}Co in this reaction. The levels at 1044.4, 1555.4, and 1757.6 keV have not been reported previously. The rest of the levels have been studied previously by means of (p,nγ), (p,γ), (n,p), (p,d), (^{3}He,d), (d,α) and (^{4}He,nγ) reactions. The present γ-ray decay information is used in conjunction with the results of previously reported (^{3}He,d) and (d,α) reactions to make definite J^π assignments to some stripping levels and to place limits for the J^π values for several other levels. When the level structure of ^{58}Co is compared with previously reported shell-model calculations, which included configurations of only lowest seniority, qualitative agreement for the first seven states is observed. (auth)

46006 STUDY OF THE IMPORTANCE OF INELASTIC PROCESSES IN STRIPPING REACTIONS ON ^{24}Mg. Mackintosh, Raymond S. (Univ. of California, Berkeley. Australian National Univ., Canberra). Nucl. Phys.; A170: No. 2, 353-68 (1971).

The source term technique for including both entrance and exit channel rotational excitations in stripping reactions has been applied to the reaction ^{24}Mg(d,p) leading to the ground band and first excited band of ^{25}Mg. Inelastic processes in both entrance and exit channels prove to be important for correct relative cross sections (i.e. for correct spectroscopic factors) and for improving angular distributions. (auth)

46007 ELECTROMAGNETIC PROPERTIES OF sd SHELL NUCLEI. Arima, A. (Tokyo Univ.); Sakakura, M.; Sebe, T. Nucl. Phys.; A170: No. 2, 273-308(1971).

The electromagnetic properties of the nuclei ^{19,20}O, ^{19,20,21}F, ^{19,20,21,22}Ne, ^{21,22}Na and ^{22}Mg are studied in a shell-model basis in which the valence nucleons are restricted to the (0d, 1s) shell and the ^{16}O core is assumed to be inert. Central two-body interactions are taken as the residual interactions. Beyond mass number A = 20, the SU(3) and SU(4) groups are used to truncate the shell-model space to a dimension less than sixty. Good agreement with experiment is obtained, except for ^{22}Na. (auth)

46008 STUDY OF THE STATES OF ^{60}Ni, ^{62}Ni, ^{64}Ni, AND ^{66}Ni USING THE (t,p) REACTION. Darcey, W. (Oxford Univ.); Chapman, R.; Hinds, S. Nucl. Phys.; A170: No. 2, 253-72(1971).

The (t,p) reactions on the even isotopes of nickel have been studied at a bombarding energy of 12 MeV using the Aldermaston multiangle magnetic spectrograph and tandem Van de Graaff. States of the final nuclei were identified up to excitation energies of about 6 MeV and Q-values were measured. From the shapes of the proton angular distributions a number of states with J^π = 0^+, 2^+, 3^- and 4^+ were identified. Where comparison is possible the agreement with previous spin and parity assignments is good. The present results on ^{66}Ni represent the first investigation of the states of this nucleus. Fifty-nine levels up to an excitation energy of 6.7 MeV were identified and 13 assignments of spin and parity were made. The (t,p) cross sections to the nickel ground states are larger by factors of 5 to 10 than the yields to any of the excited states. The 2^+ and 3^- vibrational states receive an appreciable strength. As expected, no strongly populated 0^+ excited states were observed. (auth)

46009 CALCULATION OF THE NUCLEAR PROPERTIES OF ^{53}Cr BY THE UNIFIED MODEL. Csueroes, M. (Central Re-

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search Inst. for Physics, Budapest); Cameron, J. A.; Zamori, Z. Can. J. Phys.; 49: 1582-8(15 Jun 1971).

The results of a calculation based upon the intermediate coupling approach of the unified model are presented for the low energy nuclear properties of the ^{53}Cr isotope. (auth) (Canada)

46010 ISOSPIN STRUCTURE OF AN E2 TRANSITION MATRIX ELEMENT IN ^{27}Al AND ^{27}Si. Main, I. G.; McCrone, B. T.; Crossfield, B. E.; (and others) (Univ. of Liverpool). J. Phys., A (London): 4: No. 3, L59-63(May 1971).

E2/M1 mixing ratios have been measured for transitions from the second ($^3/_2^+$), third ($^1/_2^+$) and fourth ($^5/_2^+$) excited states of ^{27}Si. A discrepancy in the magnitudes of the mixing ratios for the $^5/_2^+ \rightarrow$ ground state transition in ^{27}Al and ^{27}Si is confirmed, and is used to estimate the ratio of the isovector to the isoscalar components of the E2 matrix element for the transition. (auth) (UK)

46011 EVIDENCE FOR AN ISOMERIC $^{19}/_2^-$ STATE OF THE $(\pi(f_{7/2})^1, \nu(f_{7/2})^2{}_{6}^{+})$ CONFIGURATION IN ^{43}Sc. Sawa, Z.; Sztarkier, J.; Bergstroem, I. (Forskningsinstitutet for Atomfysik, Stockholm). Phys. Scr.; 6: 261-3(1970).

Using pulsed alpha beams from one 80 cm and one 225 cm cyclotron an isomeric state in ^{43}Sc at 3123 keV having a half-life $T_{\frac{1}{2}} = (0.5 \pm 0.1)$ μs was found in the reaction ^{40}Ca(α,p)^{43}Sc. This isomeric state is interpreted as the $^{19}/_2^-$ level of the $(\pi(f_{7/2})^1, \nu(f_{7/2})^2{}_{6}^{+})$ configuration. It decays to levels at 2987 keV, 1830 keV, and the $f_{7/2}$ ground state by emission of three cascade γ-rays of energies 135.8 ± 0.2, 1157.1 ± 0.2, and 1830.1 ± 0.5 keV. The 2987 and 1830 keV states are suggested to have spins and parities $^{15}/_2^-$ and $^{11}/_2^-$ respectively. (auth) (Sweden)

46012 POSITIVE-PARITY BANDS IN ^{29}Si. Pilt, A. A.; Spear, R. H.; Elliott, R. V.; Kuehner, J. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: 1263-74(15 May 1971).

A study was made of several high spin members of the ground state ($K^\pi = ^1/_2^+$) and first-excited state ($K^\pi = ^3/_2^+$) rotational bands in the presumed oblate nucleus ^{29}Si. Gamma-ray angular distribution and linear polarization measurements have confirmed the spin and parity of the 4081 keV level to be $^7/_2^+$, and levels at 4742 and 5283 keV were shown to have $J^\pi = ^9/_2^+$ and ($^7/_2^+$, $^3/_2^+$) respectively. Branching and mixing ratios for the transitions from these states were also determined; in conjunction with previously measured lifetimes, transition strengths are calculated. The results are compared with the predictions of a Nilsson-model calculation including the effects of coriolis mixing of the low-lying positive parity bands. (auth) (Canada)

46013 SOME ODD Z NUCLEI IN THE $63 \leq A \leq 89$ MASS REGION IN THE FRAMEWORK OF THE INTERMEDIATE COUPLING MODEL. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Regina). Can. J. Phys.; 49: 1750-68(1 Jul 1971).

The level structures of the nuclei ^{63}Cu, ^{69}Ga, ^{75}As, ^{79}Br, ^{83}Rb, and ^{89}Y are investigated in the framework of the unified model. Each nucleus is considered to consist of an even–even vibrating core and extra-core proton quasiparticle. The quasiparticle–core interaction Hamiltonian is assumed to be given by a dipole plus a quadrupole term. The coupling of a $g^9/_2$ state to the vibrating core leads to the formation of states of positive parity with $^5/_2^+ \leq I \leq ^{13}/_2^+$. Such states with I up to $^{11}/_2^+$ were recently observed in the nuclei under investigation. In the case of negative parity states the extra core proton quasiparticle is assumed to have available the $p^3/_2$, $p^1/_2$, and $f^5/_2$ states. Many features of the investigated nuclei are explained by the model at least qualitatively. The present calculations do not exhaust the possibility of improved results. Future experimental data will be highly desirable not only for testing but also for improving the model. (auth) (Canada)

46014 INTERMEDIATE COUPLING IN ^{55}Fe. Csueroes, M. (Inst. of Isotopes, Budapest); Cameron, J. A.; Zamori, Z. Can. J. Phys.; 49: 1832-5(1 Jul 1971).

Calculations based on the collective model with intermediate coupling between the surface oscillations of the even–even core ^{54}Fe and 29th neutron were carried out. Level energies, spectroscopic factors, and electromagnetic properties are obtained in good agreement with experiment. (auth) (Canada)

46015 GAMMA RAYS FROM NEUTRON RESONANCE CAPTURE IN Mg, Si, P, AND S. Lundberg, B.; Bergqvist, I. (Forsvarets Forskningsanstalt, Stockholm). Phys. Scr.; 2: No. 6, 265-71(1970).

The gamma-ray spectra from neutron resonance capture in Mg, Si, P and S (natural samples) in the energy range 10–75 keV have been recorded. The gamma-ray spectrometer was a NaI(Tl) crystal, 20.8 cm long and 22.6 cm in diameter. Time-of-flight techniques were used. The gamma-ray spectra were found to be dominated by a few intense primary gamma-ray lines to low-lying levels in agreement with previous observations. Branching ratios are given for the dominating primary lines. (auth) (Sweden)

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Refer also to abstracts 44650, 44659, 44719, 44742, 45837, 45897, 45906, 45912, 45913, 45941, 45948, 45961, 45971, 46000, 46004, 46105, 46106, and 46134.

46016 (CEA-N-1390) NUCLEAR PHYSICS DEPARTMENT. Progress Report, October 1, 1969–September 30, 1970. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 213p. (In French). Dep. NTIS (U. S. Sales Only).

Progress is reported on the nuclear physics experiments conducted using the Saclay and Grenoble accelerators (Tandem Van de Graaff, variable energy cyclotrons, electron linear accelerator). Separate abstracts have been prepared for each of the three sections. (France)

For abstracts of individual sections see: 45912, 45913, and 45948.

46017 (COO-1746-56) E2/M1 MULTIPOLE MIXING RATIOS OF GAMMA TRANSITIONS IN THE "QUASI-SPHERICAL" NUCLEUS ^{132}Xe. Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1971]. 42p. Dep. NTIS.

The E2/M1 multipole mixing ratios $\delta(\gamma) = \langle I_f||\hat{T}_N^{(E)}||I_i\rangle / \langle I_f||\hat{T}_N^{(M)}||I_i\rangle$ of 10 gamma transitions in the quasi-spherical nucleus ^{132}Xe have been measured by means of gamma-gamma directional correlations observed with two coaxial Ge(Li) detectors. Spin assignments have been made for the levels at 1963 keV (4^+), 2110 keV (4^+), 2112 keV (6^+), 2395 keV (4^+), 2584 keV (5^+), 2589 keV (3), 2614 keV (4^+), and 2839 keV (5^+). In addition, previous spin assignments for levels below 1900 keV were confirmed. Based on the proposed spin assignments, the following values of the quadrupole-dipole mixing ratios were obtained (energies in keV): δ(506) = −1.3 ± 0.4; δ(523) = −0.25 ± 0.15; $\delta(630) = +5.3^{+\infty}_{-1.0}$; δ(727) = −0.32 ± 0.04; δ(955) = −0.15 ± 0.05; δ(1136) = +0.9 ± 0.3; δ(1143) = $-(0.04^{+0.09}_{-0.04})$; δ(1173) = −0.40 ± 0.15; δ(1291) = +0.01 ± 0.08; δ(1399) = +0.07 ± 0.02. The results are discussed in terms of the collective vibrational model and in terms of a quasirotational model. However, these models are of limited value in explaining the experimental data concerning the level structure and multipole transitions of ^{132}Xe. (auth)

46018 (JAERI-13669) MULTI-GROUP CONSTANTS FOR FISSION PRODUCT NUCLIDES (2). Tone, Tatsuzo; Tomioka, Hidetake (Japan Atomic Energy Research Inst., Tokai). Jul 1969. 107p. NTIS (U. S. Sales Only).

Multigroup constants of (n,γ) reactions for 65 nuclides of fission products, which have been calculated by the use of the resolved-resonance parameters in BNL-325 (2nd ed. suppl. 2), are given. A part of the results are compared with previous results [JAERI-13029] and the ABN set. (auth) (Japan)

46019 (JINR-P4-5825) CORRELATIONS BETWEEN PARTIAL RADIATIVE WIDTHS IN NEUTRON RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The cases in which there may exist significant correlations between reduced neutron widths for transition from neutron resonances to definite final states are considered. Some suggestions on the determination of the degree of K-forbiddenness for E1 and M1 transitions from neutron resonances to low-lying states are given. It is indicated what nuclei are the most favorable for studying experimentally the correlation between radiative widths and for determining the degree of K-forbiddenness. (auth)

46020 (JINR-P6-5794) NEW INFORMATION OF ^{132}Ba LEVELS EXCITED IN THE DECAY OF ^{132}La AND ^{132m}La. Amov, B.; Vylov, Ts.; Enikova, M.; Zhelev, Zh.; Lebedev, N. A.; Penev, I.; Fominykh, V. I.; Herrmann, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Spectra of conversion electrons, of γ rays, and of γγ coincidences from the decay of ^{132}La were investigated. As a result, the level scheme of ^{132}Ba is made more accurate. New levels are introduced, and quantum characteristics are ascribed to a number of these levels. The existence of a great number of levels of negative parity above 2 MeV attracts one's attention. They are supposed to be neu-

tron quasi-particle states, one of their components being "anomalous" ($I^{\pi} < 11/2^-$ instead of $= 11/2^-$). (auth)

46021 (RLO-1388-139) ANNUAL REPORT 1971. (Washington Univ., Seattle. Nuclear Physics Lab.). Contract AT(45-1)-1388. 200p. Dep. NTIS.

Research and development progress at the Nuclear Physics Laboratory of the University of Washington during the year ending April 15, 1971, is outlined. Topics include accelerator development, ion source development, instrumentation for research, detector systems, computer systems, reactions and scattering with light nuclei, nuclear astrophysics, β-decay and electron pairs, reactions and scattering (A > 16), angular correlations, gamma rays from nuclei, fission, and research performed by user or visitor groups. (W.H.K.)

46022 E2/M1 RATIOS IN THE 427.90 AND 635.90 keV TRANSITIONS OF ^{125}Te. Barrette, J.; Barrette, M.; Boutard, A.; Lamoureux, G.; Monaro, S. (Univ. of Montreal). Nucl. Phys., A169: No. 1, 101-8(1971).

Gamma-gamma directional correlation measurements, performed with two Ge(Li) detectors were carried out on the (635.90-35.46), (606.68-35.46), (600.56-35.46), and (427.90-35.46) keV cascades in the decay of 2.7-yr ^{125}Sb. The result from the composite (606.68; 600.56-35.46) keV cascade was used to normalize the other two correlations. The angular correlation measurements on the other two cascades lead to mixing ratio values of $\delta(427.90) = -0.50 \pm 0.13$ or $-3.9^{+1.3}_{-2.3}$ and $\delta(635.90) = 0.34 \pm 0.05$ or $= 1.66 \pm 0.17$. For both cascades only the first value of δ is consistent with the mixing ratios obtained in nuclear orientation measurements. (auth)

46023 DETERMINATION OF THE Y_{40} COMPONENTS IN THE EQUILIBRIUM NUCLEAR SHAPES OF ^{232}Th AND ^{238}U. Moss, J. M. (CEN, Saclay, France); Terrien, Y. D.; Lombard, R. M.; (and others). Phys. Rev. Lett.; 26: No. 24, 1488-91(14 Jun 1971).

Differential cross sections were measured for the excitation, by 22.95-MeV protons, of states (up to and including the 6^+ at some angles) in the ground-state rotational bands of ^{232}Th and ^{238}U. Coupled-channel analyses of the angular distributions allow determination of the equilibrium deformation parameters β_4. The values $\beta_4 = 0.017^{+0.015}_{-0.035}$ for ^{238}U and $\beta_4 = 0.050 \pm 0.015$ for ^{232}Th do not agree well with theoretical predictions by Möller et al [Phys. Lett., 26B: 418(1968)]. (auth)

46024 STUDY OF ONE- AND TWO-NUCLEON TRANSFER REACTIONS INDUCED BY ^{16}O IONS INCIDENT ON THE EVEN Zr ISOTOPES. Nickles, R. J.; Manko, V. I.; Christensen, P. R.; Becchetti, F. D. (Univ. of Copenhagen). Phys. Rev. Lett.; 26: No. 20, 1267-70(17 May 1971).

Transitions to known single-particle states in ^{91,93,95,97}Nb are observed in the (^{16}O,^{15}N) reaction induced by the bombardment of ^{90,92,94,96}Zr with 60-MeV ^{16}O ions. Other strong transitions are also observed in this reaction, however, and evidence is presented which suggests that the final states observed are proton plus core vibrational states. The (^{16}O,^{14}C) reaction is found to populate many states in ^{92,94}Mo, but few in ^{98}Mo. The number and intensity of the states observed show a marked dependence on the neutron number of the target nucleus. The ^{12}C energy spectra for all the targets indicate that, for the nuclei and incident energies used, the main mechanism of the (^{16}O,^{12}C) reaction is breakup of the ^{16}O projectile. (auth)

46025 STATISTICS OF TIME-OF-FLIGHT MEASUREMENTS FOR NEUTRON SCATTERING EXPERIMENTS. Haelg, W. (Eidgenoessische Technische Hochschule, Zurich); Studach, T.; Meyr, H. Z. Angew. Math. Phys.; 22: 62-6(25 Jan 1971). (In German).

Some inelastic neutron diffraction investigations are based on techniques where a probability density function for the flight time is measured and where the time of arrival of a neutron at a specimen is determined by modulating the incident beam. It is demonstrated that the analogy between this probability density and the impulse response of a continuous system is only a formal one, and that the use of this analogy could lead to wrong interpretations. For incident neutrons with a Poisson distribution and for statistically independent scattering processes, the mean counting rates of different time channels are uncorrelated, and their variances show the same properties as a homogeneous Poisson process. (auth)

46026 FURTHER INVESTIGATION OF PENETRATION EFFECTS IN ^{133}Cs. Avignone III, F. T.; Trueblood, J. H. (Univ. of South Carolina, Columbia). Phys. Rev., C; 3: No. 5, 2011-17(May 1971).

The internal-conversion coefficient of the 223-keV transition was determined, from precise γ-ray and conversion intensities, as $\alpha_K(223) = 0.082 \pm 0.004$. γ-γ directional correlations of the $\gamma_{223} - \gamma_{80+81}$ and $\gamma_{276} - \gamma_{80+81}$ cascades were measured using a 33-cm^3 Ge(Li) detector and a 2 × 2-in. NaI(Tl) detector. The A_{22} coefficients are $A_{22}(\gamma_{276} - \gamma_{80+81}) = +0.100 \pm 0.004$ and $A_{22}(\gamma_{223} - \gamma_{80+81}) = -0.030 \pm 0.004$, which are consistent with $\delta(223) = -0.108 \pm 0.014$. These values of α_K and δ imply $\lambda(223) = 2$, consistent with a normal conversion process for this transition. In addition, the relative correlations of the $K_{276} - \gamma_{161}$ and $K_{276} - \gamma_{80+81}$ cascades were measured using a magnetic-lens spectrometer and 2 × 2-in. NaI(Tl) detector. The ratio of these A_{22} coefficients allows cancellation of electron scattering factors, spectrometer geometry factors, and correlation attenuation factors. The results imply $\delta(161) = +0.59$, which supports the existence of large penetration effects in the 161-keV transition. (auth)

46027 STUDY OF THE MATRIX ELEMENT OF β DECAY OF ^{139}Ba, ^{141}Ce, AND ^{148}Pm BY THE (e,e'p) REACTION. Shoda, K. (Tohoku Univ., Sendai); Sugawara, M.; Saito, T.; (and others). Phys. Rev., C; 3: No. 5, 2006-10(May 1971).

The ratio $|M^{\beta}/\xi i\int\vec{r}|$ for the first-forbidden β^- decay has been studied to discuss the composition of M^{β}. Experimental values of $|M^{\beta}|$ and $|i\int\vec{r}|$ are estimated from ft values and from the E1 matrix element. The latter was obtained from the (e,e'p) reaction through the isobaric analog states in ^{139}La, ^{141}Pr, and ^{148}Sm. The experimental value of the ratio was compared with the theory using a j-j-coupling shell model. The result shows good agreement for ^{141}Ce but not always good agreement for ^{139}Ba and ^{148}Pm. (auth)

46028 NEUTRON EMISSION AND FISSION ENERGETICS IN THE PROTON-INDUCED FISSION OF ^{233}U AND ^{238}U. Burnett, S. C.; Ferguson, R. L.; Plasil, F.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 3: No. 5, 2034-48(May 1971).

Energetics of the fission of ^{233}U induced by 8.5- and 13-MeV protons and of ^{238}U induced by 12-MeV protons have been studied by means of a three-parameter experiment in which the time of flight of one fragment and the energies of both fragments are measured. The average number of neutrons emitted from the individual fragments and from both fragments together are obtained as functions of fragment mass and total kinetic energy. The number of neutrons emitted per fragment generally increases with increasing fragment mass, and the "sawtooth" shape characteristic of neutron emission in low-excitation fission is still apparent, although the relative depths of the minimum in each of the present cases are reduced. A comparison of the number of neutrons emitted as a function of fragment mass for 8.5- and 13-MeV proton-induced fission of ^{233}U shows that excitation energies of the light fragments change only slightly, while those of the heavy fragments increase significantly with increasing bombarding energy. The largest change occurs in the mass region at about 132 amu, where the doubly-closed-shell configuration Z = 50, N = 82 occurs. Pre- and post-neutron-emission fragment mass distributions are obtained, together with the fragment energy distributions and mass-versus-energy correlations. Energy balance is studied by comparing the total energy available for fission into a given mass pair with the sum of the fragment excitation energies, calculated from neutron emission data and mass tables, and the measured fragment kinetic energies. The results are discussed within the framework of simple theoretical fission models. (auth)

46029 INVESTIGATION OF THE ^{207}Pb(α,d)^{209}Bi REACTION. Lewis, M. B.; Goodman, C. D.; Hensley, D. C. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 3: No. 5, 2027-33(May 1971).

Energy levels and differential cross sections for the ^{207}Pb(α,d)^{209}Bi reaction have been determined at an incident bombarding energy of 42 MeV. Two-nucleon distorted-wave Born-approximation (DWBA) analysis was performed for the ground and first excited levels of ^{209}Bi in order to obtain a normalization for the (α,d) and (d,α) reactions. The results of calculations using this normalization were compared with data for the 1.097-MeV 7^+ level of ^{48}Sc excited in the ^{50}Ti(d,α)^{48}Sc reaction and for the first excited state of ^{206}Tl excited in the ^{208}Pb(d,α)^{206}Tl reaction. This latter comparison confirmed an earlier argument that cross sections to the low-lying ^{206}Tl levels are considerably enhanced over pure two-hole configuration estimates. The normalized DWBA was then used to study higher-lying two-particle-one-hole excited states in ^{209}Bi. (auth)

46030 COMPARISON OF MEASURED AND THEORETICAL INTERNAL-CONVERSION COEFFICIENTS FOR L THROUGH P SHELLS OF Cm. Chu, Y. Y.; Perlman, M. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 3: No. 5, 2021-4 (May 1971).

Measurements have been made of the relative intensities of

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internal-conversion electron lines produced by the 42.9-keV pure E2 transition in ^{246}Cm. These observations of the L_1, L_2, L_3, M_2, M_3, N_2, N_3, O_2, O_3, and $P_{2,3}$ lines were made with a source of α-decaying ^{250}Cf. Results are found to be in reasonable agreement with theoretical values even for the outer shells, in which the atomic-screening effects are very large. (auth)

46031 PROMPT NEUTRONS FROM SPONTANEOUS FISSION OF ^{257}Fm. Cheifetz, E.; Bowman, H. R.; Hunter, J. B.; Thompson, S. G. (Univ. of California, Berkeley). Phys. Rev., C; 3: No. 5, 2017-21(May 1971).

The average number of prompt neutrons ($\bar{\nu}$) emitted in the spontaneous fission of ^{257}Fm has been measured to be 3.97 ± 0.13 (based on $\bar{\nu}$ = 3.72 for ^{252}Cf). This result and the known values of $\bar{\nu}$ for other nuclei that undergo spontaneous fission are transformed into excitation-energy values and compared with the liquid-drop predictions regarding the excitation-energy dependence on the fissionability parameter. (auth)

46032 (e,e'p) REACTIONS ON ^{207}Pb AND ^{209}Bi THROUGH ISOBARIC ANALOG STATES AND THE MATRIX ELEMENTS FOR THE FIRST-FORBIDDEN β^- DECAY. Shoda, K.; Suzuki, A.; Sugawara, M.; (and others) (Tohoku Univ., Sendai). Phys. Rev., C; 3: No. 5, 1999-2005(May 1971).

The radiative widths of the E1 transition through the ground isobaric analog states of ^{207}Tl and ^{209}Pb in ^{207}Pb and ^{209}Bi, respectively, were determined from the cross section of the (e,e'p) reaction. The results are 98 and 140 eV, respectively, after the correction for the interference from the continuous part of the reaction. They correspond to an effective charge of 0.56 and 21, respectively. The E1 matrix elements were determined and used for the estimation of β matrix elements $|i\xi''\int\vec{r}''|$. The result is 0.055 in natural units ($\hbar$ = c = m_e = 1) for the β-decay ^{207}Tl($3s_{\frac{1}{2}}^{-1}$) → ^{207}Pb($3p_{\frac{1}{2}}^{-1}$). In the case of ^{209}Pb($2g_{\frac{9}{2}}$) → ^{209}Bi($1h_{\frac{9}{2}}$), the result is 0.043, which is much larger than the theoretical estimate. For the E1 isobaric analog states of the first excited state of ^{209}Pb in ^{209}Bi, the radiative width and the effective charge were also determined to be 170 eV and 0.46, respectively. (auth)

46033 RESONANCE NEUTRON CAPTURE IN ^{93}Nb. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.).; Rimawi, K.; Garg, J. B. Phys. Rev., C; 3: No. 5, 2054-70(May 1971).

Spectra from radiative capture in S- and P-wave resonances in ^{93}Nb have been compared. Differences in these spectra are interpreted to indicate the presence of sizable two-particle–one-hole components in the capturing states. S-wave intensities show no correlation with (d,p) intensities to the same final states, but P-wave intensities exhibit a significant correlation. Lack of a correlation with the initial-state reduced widths rules out an appreciable channel-capture effect in this experiment. The differences in S- and P-wave total radiation widths are discussed. Seven neutron-resonance spin assignments are made, based on the capture γ-ray spectra, and 11 new final states in ^{94}Nb are observed and tabulated. (auth)

46034 COULOMB-EXCITATION MEASUREMENTS ON THE ISOTOPES ^{144}Nd, ^{146}Nd, AND ^{148}Nd. Crowley, P. A.; Kerns, J. R.; Saladin, J. X. (Univ. of Pittsburgh). Phys. Rev., C; 3: No. 5, 2049-53(May 1971).

The value of the reduced transition probability B(E2,$0^+ \rightarrow 2^+$) and the static quadrupole moments of the first 2^+ states of ^{144,146,148}Nd were determined. The results are discussed in terms of the variable-moment-of-inertia model. (auth)

46035 DECAY STUDIES OF ^{101m}Rh AND ^{101g}Rh. Sieniawski, J.; Pettersson, H.; Nyman, B. (Uppsala Univ.). Z. Phys.; 245: No. 1, 81-96(1971).

The level structure of ^{101}Ru was investigated from the decays of ^{101m}Rh and ^{101g}Rh. For the gamma-ray measurements Ge(Li) detectors with effective volumes of 24 and 43 cm^3 were used for singles and coincidence work, and several new transitions were observed. Conversion electron spectra from the ^{101m}Rh decay were investigated with a 50 cm double-focussing beta spectrometer. K-conversion coefficients were determined by combining internal conversion and gamma-ray intensities. For the stronger transitions probable multipolarity assignments have been obtained from these coefficients and also from K/L and L-subshell ratios. All transitions observed were fitted into a decay scheme, in which tentative spin-parity assignments of all states are given. (auth)

46036 LEVEL STRUCTURE OF ^{203}Tl, ^{205}Tl, AND ^{208}Bi EXTRACTED OUT OF THE GAMMA SPECTRA AFTER NON-ELASTIC NEUTRON SCATTERING. Feicht, E. J.; Goebel, H. (Technische Univ., Munich). Z. Phys.; 245: No. 1, 13-30 (1971). (In German).

Fast neutrons from a nanosecond-pulsed D(d,n)^{3}He neutron source were scattered from thallium, those of T(d,n)^{4}He from bismuth. A time-gate-technique provided a relatively low background. The gamma-spectrum arising from nonelastic scattering was analyzed by a high resolution Ge(Li)-spectrometer. The observed γ-transitions were combined to the level scheme. The experimental population-cross-sections were compared with results of a statistical model calculation. (auth)

46037 NUCLEAR MATRIX ELEMENTS FOR THE FIRST FORBIDDEN β-DECAY OF ^{198}Au. Van Eijk, C. W. E. (Univ. of Tech., Delft, Netherlands). Nucl. Phys.; A169: No. 2, 239-47(1971).

Nuclear matrix elements for the first-forbidden β-decay of ^{198}Au were extracted from experimental data. The following results were obtained: $\int\gamma_5 = 0.007 \pm 0.016$, $\int i\sigma \cdot r/\rho = -0.010 \pm 0.058$, $\int\alpha = 0.012 \pm 0.005$, $\int ir/\rho = 0.028 \pm 0.020$, $\int\sigma \times r/\rho = 0.010 \pm 0.011$, $\int iB_{ij}/\rho = 0.029 \pm 0.010$, $\int ir/\rho(r/\rho)^2 / \int ir/\rho = 0.95 \pm 0.95$. (auth)

46038 GAMMA–GAMMA DIRECTIONAL CORRELATIONS IN ^{135}Xe FOLLOWING THE DECAY OF ^{135}I. Macias, E. S.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys.; A169: No. 2, 305-16 (1971).

The level scheme of ^{135}Xe was investigated via the angular correlation of γ-rays using a Ge(Li) and a NaI(Tl) detector. The angular correlation of the 526.5–1131.6, 836.8–1131.6, 1124.1–1131.6, 417.5–1260.5, and 220.5–1458.1 keV γ-ray cascades were measured. The spin and parity of the 2256.7, 1968.4, 1448.6 and 1131.6 keV levels were deduced to be $\frac{7}{2}^+$ $\frac{5}{2}^+$, $\frac{3}{2}^+$, and $\frac{7}{2}^+$ respectively. The levels of ^{135}Xe are compared to the level structure of other N = 81 isotones and are discussed in the context of the particle-core coupling model. (auth)

46039 NEUTRON CAPTURE γ-RAYS FROM ^{192}Ir AND ^{194}Ir. Krueger, H.; Hanle, H.; Koriath, M.; Stelzer, K. (Univ., Frankfurt am Main). Nucl. Phys.; A169: No. 2, 363-84(1971).

The reactions ^{191}Ir(n,γ)^{192}Ir and ^{193}Ir(n,γ)^{194}Ir with reactor neutrons were investigated in order to get information on the nuclei ^{192}Ir and ^{194}Ir. The high-energy γ-ray spectra measured with a Ge(Li)–NaI(Tl) pair spectrometer give 123 transitions in ^{192}Ir and 106 transitions in ^{194}Ir leading to levels between the ground states and 1700 keV of excitation energy. The neutron binding energy of ^{194}Ir is B_n = 6066.1 ± 1.5 keV. The ^{191}Ir ground state transition cannot be measured because of its high multipolarity. There is evidence that the highest energy transition goes to the 58 keV 1^+ excited state. The neutron binding energy is then B_n = 6198.7 ± 2.0 keV. The proposed level schemes are based on these binding energy values. Some additional information has been extracted on the 32 ms isomeric state in ^{194}Ir. Low-energy spectra up to 500 keV were measured with single Ge(Li) detectors. The ^{192}Ir high-energy spectrum taken with a cadmium-filtered neutron beam shows large intensity changes compared to the thermal-capture spectrum. (auth)

46040 ^{210}Pb(t,p)^{212}Pb REACTION. Ellegaard, C. (Carnegie-Mellon Univ., Pittsburgh); Barnes, P. D.; Flynn, E. R. Nucl. Phys.; A170: No. 1, 209-13(1971).

The ^{210}Pb(t,p)^{212}Pb reaction has been carried out with 20 MeV tritons at a number of angles. The resulting energy level diagram for ^{212}Pb is remarkably similar to ^{210}Pb permitting tentative J^π assignments. The excitation strengths to the lower levels agree well with a simple pairing vibration model. All the excited levels except the first excited state are new assignments. (auth)

46041 MASSES OF ^{201}Tl, ^{202}Tl, ^{202}Pb, AND ^{203}Pb. King, C. H.; Maurenzig, P. R.; Stein, Nelson; Cleary, T. P. (Yale Univ., New Haven). Contract AT(30-1)-3223. Nucl. Phys.; A170: No. 1, 187-92(1971).

The Q-values for the reactions ^{203}Tl(p,d), ^{203}Tl(p,t), ^{204}Pb(p,d) and ^{204}Pb(p,t) have been measured and discrepancies of as much as 150 keV are found when compared with values based on the 1964 mass table. The results are compared with those derived from electron capture measurements. New masses for ^{201}Tl, ^{202}Tl, ^{202}Pb and ^{203}Pb are presented. (auth)

46042 HIGH-ENERGY DIPOLE RADIATION FROM RESONANCE NEUTRON CAPTURE IN ^{105}Pd. Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M. (CBNM–EURATOM, Geel, Beglium. CNEN, Bologna). Nucl. Phys.; A170: No. 1, 153-76(1971).

The intensities of high-energy γ-rays from neutron capture in single resonances of ^{105}Pd were measured with a Ge(Li) detector by means of the time-of-flight technique. The γ-spectra of 15 s-wave resonances with known spin were studied in the range from 6.30 to 9.16 MeV. The M1 reduced widths were estimated for eight γ-lines; the average over these eight values yielded $\langle S(M1)\rangle$ = $(22 \pm 7) \cdot 10^{-9}$ MeV^{-3}. The estimate of the number of degrees of

freedom of the M1 widths distribution was consistent with $\nu = 1$. The E1 reduced widths were estimated for seven γ-lines; the average over these seven values yielded $\langle S(E1)\rangle = (54 \pm 22) \cdot 10^{-9}$ MeV^{-3}. New information about the spin of nine low-lying levels of ^{106}Pd was obtained. (auth)

46043 NUCLEAR MASSES, SHELL-MODEL, AND SUPER-HEAVY NUCLEI. II. Koehler, H. S. (Univ. of Arizona, Tucson). Nucl. Phys.; A170: No. 1, 88-110(1971).

In the first paper in this series two forms of effective (K-matrix) interaction were used in self-consistent field calculations on some closed-shell nuclei. Both were velocity dependent to simulate the Serber character of the force. One of them, which defined model A, did not depend explicitly on the nuclear medium. The second, model B, contained a density-dependent short-ranged repulsion of the same strength for both n-n and n-p interactions. In this paper the effect of the tensor force is approximated by allowing the n-p interaction to be density dependent. This defines model C. In model D the effect of the binding on the two-body interaction (dispersion effect) is included approximately. Both models C and D give a spectacular improvement in single-particle spectra over the previous models. The contribution of the second-order rearrangement to the energies of hole states in ^{208}Pb is estimated from calculations for nuclear matter. It is found to increase the agreement with the experimental spectrum. In ^{298}114 the proton $f_{\frac{5}{2}}$-$f_{\frac{7}{2}}$ splitting is 2.7 MeV for both models C and D, but the (occupied) $i_{13/2}$ level is located between the f-levels, so that the gap at Z = 114 is reduced to 1.9 and 1.1 MeV in models C and D, respectively. The gap at N = 184 is 2.3 and 2.5 MeV, respectively. (auth)

46044 GAMMA-RAY SPECTRA FROM INELASTIC SCATTERING IN NIOBIUM. Blow, S. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 94: No. 3, 413-20(1971).

A method for generating γ-ray production probabilities for inelastic neutron scattering in niobium is described. In fission reactors the main source of γ radiation is the fission process itself, and secondary γ-ray production is of minor importance; but in a model fusion reactor blanket some 28% of the energy deposited is converted to γ rays. Nonelastic processes create this γ radiation, and the most important nonelastic reaction is inelastic scattering. Various theoretical methods are discussed, and one appropriate to the analysis of $^{93}_{41}$Nb is selected. This method is based on Troubetzkoy's formalism [Phys. Rev., 122: 212(1961)] with parameters adjusted to give reasonable agreement with the experimental data of Drake et al. [Nucl. Sci. Eng., 40: 294(1970)] on inelastic scattering in niobium at 6.0 MeV. The γ-ray spectra calculated at various incident neutron energies are converted into γ-ray production probabilities. By integrating these probabilities with the inelastic cross section and neutron spectra, both an intensity and spectral description of the source γ rays are obtained. This source description is the necessary starting point for calculating γ-ray spectra in the reactor blanket. (auth)

46045 ISOMERIC ACTIVATION OF SILVER WITH BREMSSTRAHLUNG. Law, Joseph J. (Longwood Coll., Farmville, Va.). J. Nucl. Sci. Technol. (Tokyo): 8: No. 6, 351-3(Jun 1971).

The photopeak counts of ^{107m}Ag and ^{109m}Ag produced with bremsstrahlung from a 3.5-MeV electron beam are compared, and the values of the activation cross sections for ^{107}Ag$(\gamma,\gamma')^{107m}$Ag and ^{109}Ag$(\gamma,\gamma')^{109m}$Ag are given. (R.W.R.)

46046 STATISTICAL CONSTRUCTION OF RESONANCE STRUCTURE IN THE UNRESOLVED RESONANCE REGION. II. Ohnishi, Tadahiro; Ueda, Yasuyuki (Hitachi Ltd., Japan). J. Nucl. Sci. Technol. (Tokyo): 8: No. 6, 349-51(Jun 1971).

A method for the statistical construction of resonance structures in the unresolved-resonance energy region is reported. It is required that the resonance structure to be generated should reproduce the evaluated values of fine-group average cross sections on all of the fine groups in the whole energy range of interest. After a brief description of the method, it is applied to calculate the fission cross sections and α values for ^{239}Pu. (R.W.R.)

46047 POSSIBILITY OF DETECTING LONG-LIVED TRANSURANIC ELEMENTS IN NATURE. Bonchev, T. V.; Peneva, S. K. (Univ., Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 1, 31-4(1971).

Predictions of half-lives for transuranic elements in the range 10^8 to 10^{10} years justify searching for them in the earth's crust. Various guidelines as to those minerals with which the transuranics might be associated, based on rules for the isomorphism of minerals accepted in geochemistry, are set forth. Experimental methods for the detection of these elements in various samples are discussed. (R.W.R.)

46048 INTERACTION OF CHARGED PARTICLES WITH MATTER–dE/dX MEASUREMENTS OF ^{235}U FISSION FRAGMENTS AS A FUNCTION OF MASS AND ENERGY USING TIME-OF-FLIGHT TECHNIQUE. Abdel-Messih, Youhanna Fares. Gainesville, Fla.; Univ. of Florida (1970). 229p. University Microfilms Order No. 71-12,730.

Thesis.

The rate of energy loss of ^{235}U fission fragments in nickel was measured using the correlated energy–time-of-flight technique. This method yields the initial energies E_I and velocities V(1) and the final energies E_R and velocities V(2) of the fragments before and after degradation in the nickel foils. The masses are immediately determined. The results are graphically presented in the form of the following correlations: $-1/Z^2\ dE/dx$ vs E/M, $-dE/dx$ vs E/M, Δx vs E_R, Δx vs ΔE, and $-dE/dx$ vs E_I; Z is the most probable charge of the fission fragment and Δx is the thickness of the nickel foil in mg cm^{-2}. All correlations are presented for masses 80 through 110 and 130 through 145 in 5 amu intervals. A simple range–energy relation of the form $R = KE^{\alpha}$ was fitted to the data points. K was found to be mass dependent and decreases with increase of the ion mass. For $\alpha = 0.75$, best range–energy results were obtained for K = 0.176. The value of the constant K was determined from the values of the ranges and kinetic energies of the median light and median heavy fragments, i.e., high-yield products, and extrapolated to products of low yield. (Diss. Abstr. Int., B.)

46049 ALPHA DECAY OF ^{255}Md, ^{256}Md, AND ^{257}Md. Hoff, R. W.; Hulet, E. K.; Dupzyk, R. J.; Lougheed, R. W.; Evans, J. E. (Univ. of California, Livermore). Nucl. Phys.; A169: No. 3, 641-50(1971).

The α-decay of ^{255}Md, ^{256}Md, and ^{257}Md has been studied following production of these isotopes in a series of helium-ion bombardments of an einsteinium target. The mendelevium was collected as the atoms recoiled from the target during bombardment. Following chemical purification the mendelevium was separated into various mass fractions in an electromagnetic isotope separator. The α-particle emission of each fraction was examined with the following results: ^{255}Md, $T_{\frac{1}{2}} = 27 \pm 3$ min, α/total = 0.100 ± 0.014, $E_\alpha = 7.340 \pm 0.005$ MeV; ^{256}Md, $T_{\frac{1}{2}} = 77 \pm 5$ min, α/total = 0.099 ± 0.005, $E_\alpha = 7.16 \pm 0.015$ MeV (16 ± 2%), $E_\alpha = 7.23 \pm 0.01$ MeV (63 ± 4%), $E_\alpha = 7.33 \pm 0.03$ MeV (4 ± 1%), $E_\alpha = 7.46 \pm 0.03$ MeV (5 ± 1%), $E_\alpha = 7.49 \pm 0.02$ MeV (6 ± 1%), $E_\alpha = 7.67 \pm 0.03$ MeV (2 ± 1%), $E_\alpha = 7.72 \pm 0.02$ MeV (4 ± 1%); ^{257}Md, $T_{\frac{1}{2}} = 300 \pm 20$ min, α/total < 0.26, $E_\alpha = 7.075 \pm 0.020$ MeV. The observed α-decay rates are compared with calculated values derived from α-decay theory. Lower limits have been determined for the partial spontaneous fission half-lives: ^{255}Md > 12 d, ^{256}Md > 2 d, ^{257}Md > 6 d. (auth)

46050 IN-BEAM GAMMA-RAY SPECTROSCOPY OF EVEN Mo AND Ru ISOTOPES. Lederer, C. M.; Jaklevic, J. M.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Phys.: A169: No. 3, 449-88(1971).

Excited states of ^{92,94,96,98}Mo and ^{94,96,98,100,102}Ru were studied by in-beam γ-ray spectroscopy. The decays of levels populated by the $(\alpha,2n)$ reaction on even isotopes of Zr and Mo were studied by measurement of the γ-singles spectrum, beam-γ-delay, $\gamma\gamma$-coincidences (prompt and delayed), and γ-ray angular distributions. The most notable new feature of these experiments is the use, in-beam, of a sensitive coincidence technique, employing two Ge(Li) spectrometers in conjunction with a two-parameter incremental data-acquisition system, to establish the placement of weak transitions. The level schemes are compared with previous studies of these nuclei. A considerable number of new levels, predominately of high spin (I > 6), were observed. The observed levels are analyzed in terms of systematics and, where available, detailed shell-model calculations. A general description in terms of excitations in the low-lying orbitals outside a 38-proton + 50-neutron core appears adequate to explain much of the data, particularly in those nuclei near the 50-neutron shell. The data are also compared to recent macroscopic calculations of quasi-rotational bands, the VMI model. The observed spin distribution in the residual nuclei indicates a net loss of angular momentum in the emission of neutrons and/or unresolved γ-rays. Calculations based on a microscopic model for neutron evaporation suggest that, with a moment-of-inertia parameter $\mathcal{I} = 0.5\mathcal{I}_{rigid}$, the angular-momentum loss can be accounted for entirely by the neutrons, whereas for $\mathcal{I} > 0.5\ \mathcal{I}_{rigid}$, some of it must reside in the unplaced γ-ray transitions. (auth)

46051 IN-BEAM GAMMA-RAY SPECTROSCOPY OF ODD-NEUTRON Mo AND Ru ISOTOPES. Lederer, C. M.; Jaklevic, J. M.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Phys.: A169: No. 3, 489-503(1971).

Levels of Mo and Ru isotopes, excited by the reactions ^{94}Zr-$(\alpha,3n)^{95}$Mo, ^{96}Zr$(\alpha,3n)^{97}$Mo, ^{92}Mo$(\alpha,n)^{95}$Ru, ^{94}Mo$(\alpha,n)^{97}$Ru, ^{98}Mo-

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(α,3n)^{99}Ru, and ^{100}Mo(α,3n)^{101}Ru, have been studied by in-beam γ-ray spectroscopic techniques (γ-singles spectra, beam-γ delay, $\gamma\gamma$ coincidence, and γ-ray angular distributions). A new isomer, $t_{½}$ = 8 ns, is found in ^{95}Ru. Much of the new information concerns high-spin states. In ^{95}Mo, a number of these states are predicted by calculations for the configuration $(\pi p_{½})^2\ (\pi g_{9/2})^2\ (\nu d_{5/2})^3$, and most of the others can be accounted for qualitatively by inclusion of other neutron orbitals, primarily $g_{½}$ and $h_{11/2}$ for the high-spin states. Similar shell-model structures are inferred for some levels in ^{97,99,101}Ru. In ^{101}Ru and ^{99}Ru sequences of high-spin, odd-parity states which can be characterized as phonon bands coupled to an $11/2^-$ particle state were also observed. (auth)

46052 DECAY SCHEME OF ^{93}Y. Hontzeas, S.; Marsden, D. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A169: No. 3, 504-12(1971).

Active yttrium has been separated from the fission products of ^{235}U and the decay of 10.25 h ^{93}Y to the levels of ^{93}Zr has been studied with the aid of two Ge(Li) detectors and coincidence equipment. Gamma-ray energies and intensities of twenty-one lines were determined. Excited states in ^{93}Zr were observed at 267, 947, 1425, 1451, 1652, 1914, 1993, 2181, 2350, 2453, 2468, 2608, and 2773 keV. In addition, evidence is presented for the existence of an excited state at 1168 keV which may correspond to the $5/2^+$ level predicted by Talmi. Branching ratios and log ft values have been calculated. The level scheme proposed for ^{93}Zr agrees in general with the level scheme derived by Knight et al., Arad et al. and Cohen and Chubinsky. (auth)

46053 DECAY OF 5.1 min ^{164m}Tm (A NEW ISOMER). THE ^{164}Yb(75 min) → ^{164}Tm (2.0 min) → ^{164}Er DECAY CHAIN. De Boer, F. W. N.; Goudsmit, P. F. A.; Koldewijn, P.; Meijer, B. J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys.; A169: No. 3, 577-99(1971).

The decay of the 5.1 min isomeric state and of the 2.0 min ground state of ^{164}Tm has been studied with high-resolution Ge(Li) and Si(Li) detectors. The ^{164}Tm ground state has spin-parity 1^+ and Nilsson assignment (p[523]↑ − n[523]↓). Its decay takes place in 80% of the cases by fast β-transitions to the 2^+ and the 0^+ levels of the ground state rotational band in ^{164}Er. In addition the 4^+ state of the same band, the 2^+, 3^+, and 4^+ states of the γ-vibrational band, the 0^+, 2^+, and 4^+ states of the β-band, the 1^-, 3^- states of a K = 0 octupole vibrational band and several two-quasiparticle states in ^{164}Er are excited. The ^{164m}Tm isomeric state, for which the assignment 6^-(p[404]↓ + n[523]↓) is proposed, decays in 20% of the cases by an allowed unhindered electron capture transition to a level assigned as 7^-(p[404]↓ + p[523]↑), at 1985.01 keV in ^{164}Er. In the γ-decay of this level (half-life 22.7 ns), the 2^+, 4^+, 6^+ and 8^+ states of the ground state rotational band, the 3^+, 4^+, 5^+, 6^+, and 7^+ states of the γ-vibrational band and three two-quasiparticle states in ^{164}Er are excited. A parameter Z_2 for mixing between the ground state and γ-vibrational bands in ^{164}Er of 0.065 ± 0.008 was deduced. The data indicate that approximately 80% of the decays of the 5.1 min ^{164}Tm isomeric state populate the ^{164}Tm ground state, probably by a cascade of unobserved M3 and M2 transitions with a 3^-(p[411]↓ + n[523]↓) state as an intermediate level. A lower limit of 95% per decay is given for the intensity of the electron-capture transition to the ^{164}Tm ground state from the ^{164}Yb ground state. (auth)

46054 ^{241}Am SPONTANEOUS FISSION DECAY CONSTANT MEASURED WITH SOLID STATE TRACK RECORDERS. Roberts, J. H. (Northwestern Univ., Evanston, Ill.); Gold, R.; Armani, R. J. pp VIII.15-19 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The spontaneous fission decay constant of ^{241}Am has been determined by fission track counting in mica to be (6.53 ± 0.26) × 10^{-15}/year. Several samples of ^{241}Am electroplated on platinum to various thicknesses were used in the measurement. Efficiency calibrations of the various samples were carried out by irradiations in a uniform flux of slow neutrons and subsequent fission track counting in mica. Good internal consistency of the results over a wide range of track densities was obtained. The mass of the ^{241}Am samples was determined by alpha counting. (auth) (France)

46055 SPONTANEOUS FISSION OF LEAD: SEARCH FOR VERY FAR TRANSURANIUM ELEMENTS. Flerov, G. N.; Perelygin, V. P. (Joint Inst. for Nuclear Research, Moscow). pp VIII.20-26 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

Tracks of nuclear fission fragments in Pb and its compounds were recorded with dielectric track detectors. For the lead glass this effect corresponds to the spontaneous fission half-life of Pb (2 to 3) × 10^{20} years. Various possible sources of the effect are analyzed. The existence of a long-lived spontaneously fissionable transuranic nuclide is a possible interpretation of the activity studied. (auth) (France)

46056 INVESTIGATIONS ON TERNARY PHOTOFISSION WITH TRACK RECORDERS OF DIFFERENT SENSITIVITY. Medveczky, L.; Somogyi, G. (Magyar Tudomanyos Akademia Atommag Kuttato Intezete, Debrecen, Hungary). pp VIII.65-82 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The existence of the ternary photofission of ^{232}Th, ^{238}U and ^{239}Pu induced by a 27.5 MeV bremsstrahlung beam was studied simultaneously with track detectors of different threshold. In sandwiches prepared from both muscovite mica and plastic Melinex O about 1.5 million binary fission events were scanned. Data are given for the frequency of three prong events, two-prong events with a space angle smaller than 180°, and recoil events produced by the fission fragment scattered on ^{39}K and ^{16}O occurring in the material of the mica and plastic detectors, respectively. For the two first cases the range and angular distributions are presented. Results obtained in mica and plastic are compared. A background consisting of short tracks was discovered in plastic sandwiches containing ^{239}Pu. The track density shows a correlation with the concentration of target nuclei and the storage time before etching. A possible origin of these tracks is discussed. (auth) (France)

46057 STUDY OF THE FISSION AND FRAGMENTATION OF HEAVY NUCLEI BY HIGH ENERGY PROJECTILES. Stein, R.; Remy, G.; Ralarosy, J.; Tripier, J.; Debeauvais, M. (Univ., Strasbourg). pp VIII.83-94 of Proceedings of the International Topical Conference on Nuclear Track Registration in Insulating Solids and Applications, Held at Clermont-Ferrand, France, May 6–9, 1969. Vol. 2. /Isabelle, D. (ed.). Clermont-Ferrand, France; Universite de Clermont-Ferrand (1969). (In French).

From International topical conference on nuclear track registration in insulating solids and applications; Clermont-Ferrand, France (6 May 1969). See CONF-690522-(Vol.2).

The fission of heavy nuclei by alpha particles of energies up to 100 MeV was studied using the Makrofol as a detector. Using some rather involved techniques, it is easy to obtain accurate values for certain cross sections and mass and energy distributions. Events whose probabilities of occurrence are small may be counted, indexed, and studied kinetically and dynamically providing the different geometric parameters are known. (France)

46058 ENERGY LEVELS IN ^{251}Cf VIA ALPHA DECAY OF ^{255}Fm. Ahmad, I.; Porter, F. T.; Freedman, M. S.; (and others) (Argonne National Lab., Ill.). Phys. Rev., C; 3: 390-407(Jan 1971).

The γ-singles and conversion-electron spectra of ^{255}Fm were measured with a Ge(Li) diode and the Argonne double toroidal β-ray spectrometer, respectively. In the γ-ray spectra, in addition to the transitions expected from previously known decay schemes, γ rays of energies 63.8, 131.0, 204.1, and 264.1 keV were observed. Two new α groups, α_{368} (6.765 MeV) and α_{433} (6.701 MeV), were identified in coincidence with 131.0- and 204.1-keV γ rays. A two-parameter $\gamma-\gamma$ coincidence experiment showed that the 204.1- and 131.0-keV transitions populate the $9/2$ and $11/2$ members of the favored band. Conversion-electron studies and α-vs-γ intensity comparisons demonstrate their E1 character. The half-life of the 370.4-keV level was measured by a delayed $\alpha-\gamma$ coincidence method and found to be 1: 3 ± 0.1 μsec. On the basis of these observations and the α intensities to these levels, the 370.4- and 434.2-keV levels have been assigned to the $11/2$-(725↑) and $3/2$-(734↑) Nilsson states, respectively. A three-parameter $\alpha-\gamma$-time coincidence experiment indicates that the α intensity to the 105.73-keV (I = $7/2$, K = $1/2$) level is less than 1%,

implying that its 18% population comes primarily via a 0.57-keV transition from the 106.30-keV, I = 7/2, K = 7/2 level. The α transition probabilities to various bands are in agreement with the values expected from α-decay systematics and theoretical calculations. The K-, L-, M-, and N-sunshell atomic electron binding energies in Cf (Z = 98), obtained experimentally by least-squares adjustment from the conversion-line data, show significant deviations below recent (Bearden and Burr) tabulated values. (auth)

46059 EFFECTIVE ATOMIC NUMBERS FOR PHOTOELECTRIC AND INCOHERENT SCATTERING PROCESSES OF GAMMA RAYS. Siddappa, K.; Khayyoom, A.; Parthasaradhi, K.; Rama Rao, J. (Andhra Univ., Waltair, India). Nucl. Sci. Eng.; 45: No. 1, 94-7(Jul 1971).

At low energies the two dominant partial gamma interaction processes are photoelectric and incoherent scattering. A detailed study of the effective atomic numbers is made on the two processes for both the total and differential effect on a number of alloys. It is concluded that the effective atomic numbers for the photoelectric process can be estimated within an accuracy of 3%. At successively higher energies the uniqueness of the effective differential atomic number for the photoelectric process increases with angle in alloys. Even above the k edge up to a certain energy region, therefore, the effective atomic number for differential photoelectric process in alloys cannot be defined uniquely. (R.W.R.)

46060 $0^- \rightarrow 0^+$ DECAY OF ^{144}Pr AND THE PSEUDOSCALAR INTERACTION. Nagarajan, T. (Univ. of Madras); Ravindranath, M.; Reddy, K. Venkata. Nuovo Cim.; 3A: No. 4, 699-708 (21 Jun 1971).

The shape-factor result of Daniel and Kaschl [Nucl. Phys., 76: 97(1966)] on the $0^- \rightarrow 0^+$ transition of ^{144}Pr is at variance with all earlier reports, the latter requiring terms up to W^2. For ^{166}Ho $0^- \rightarrow 0^+$ decay, Daniel and Kaschl require terms up to W^3, whereas Beekhuis et al., who treat W_0 as a free parameter, fit the experimental shape with a fewer number of terms. In view of these disagreements, it was considered worthwhile to perform an accurate analysis of the ^{144}Pr spectral shape with the present spectrometer, which is ideally suited for such high-energy transitions as ^{144}Pr, for which scattering is a serious problem in other spectrometers. The measured shape of ^{144}Pr is $C(W) = k\{1 - (0.0975 \pm 0.013)/W\}$. An analysis employing the exact formulation of Bhalla and Rose [Phys. Rev., 120: 1415(1960)] yields $C_P/C_A \approx 10$ and a ratio of axial vector matrix elements $\lambda = -11$. These results exclude the predictions of partially conserved axial vector current theory in the form proposed by Tadic [Phys. Lett., 12: 116(1964)]. The nonzero limit of P contribution may arise due to the inadequacy of the treatment of P coupling by Rose and Osborne [Phys. Rev., 93: 1315 (1954)] or the neglect of higher-order matrix elements in the present analysis. The parameter obtained in the present work agrees with the theoretical predictions of Ahrens and Feenberg [Phys. Rev., 86: 64(1952)] and Pursey [Phil. Mag., 42: 1193(1951)] and excludes those of Rose and Osborne [Phys. Rev., 93: 1326(1954)] and Pearson [Can. J. Phys., 38: 148(1960)]. (auth)

46061 SIMULTANEOUS MEASUREMENT OF THE NEUTRON FISSION AND ABSORPTION CROSS SECTIONS OF ^{239}Pu OVER THE ENERGY REGION 0.02 eV TO 30 keV. Gwin, R. (Oak Ridge National Lab., Tenn.); Weston, L. W.; de Saussure, G.; (and others). Nucl. Sci. Eng.; 45: No. 1, 25-36(Jul 1971).

The neutron absorption and fission cross sections for ^{239}Pu were measured simultaneously over the neutron energy range from 0.02 eV to 30 keV. These cross sections were measured using an ionization chamber containing ^{239}Pu. The differential cross sections derived from these measurements are presented along with a multilevel analysis of the data up to 100 eV. A reevaluation of data obtained using a metal foil of ^{239}Pu is also made. Average values of the neutron capture and fission cross sections are presented for ^{239}Pu as obtained using the ionization chamber as well as with the metal foil. A detailed comparison of the present data is made with the results of the ENDF/B evaluation for ^{239}Pu (material 1104). The neutron cross sections presented in this report supersede the results reported previously by the authors of this report. (auth)

46062 INTEGRAL MEASUREMENT OF ^{239}Pu AND ^{233}U ALPHA. Kato, W. Y.; Armani, R. J.; Larsen, R. P.; (and others) (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 45: No. 1, 37-46(Jul 1971).

Integral values of the capture-to-fission cross-section ratio for ^{239}Pu and ^{233}U were measured in a soft-spectrum fast-reactor critical assembly by using mass spectrometric techniques to determine the capture rate. Values of 0.363 ± 0.024 and 0.10 ± 0.04 were obtained for ^{239}Pu and ^{233}U, respectively. The value of 0.363 ± 0.024 is in good agreement with the value calculated using the revised Gwin differential-cross-section data for ^{239}Pu. The value for ^{233}U is, within experimental error, in agreement with the value calculated using ENDF/B data. (auth)

46063 PHOTOFISSION CROSS SECTION OF ^{238}Pu AND ^{239}Pu. Shapiro, Alvin; Stubbins, Warren F. (Univ. of Cincinnati). Nucl. Sci. Eng.; 45: No. 1, 47-51(Jul 1971).

The photofission yields of ^{238}Pu and ^{239}Pu were measured up to 11.5 MeV with the University of Cincinnati betatron. Corona discharge spark detectors were used to detect the fission fragments from isotopically pure foils in the presence of the very high alpha-particle activity of the plutonium. The photofission cross sections were deduced from the yields by both the Penfold–Leiss procedure and Cook's least-structure analysis. They show the onset of the giant resonance. The cross section for ^{238}Pu at 7.5 MeV is 28 ± 5 mb and 21 ± 4 mb for ^{239}Pu. At 11.0 MeV, the corresponding values are 303 ± 94 mb and 221 ± 69 mb. Between 7.5 and 11 MeV, the ^{238}Pu photofission cross section is ~35% larger than that for ^{239}Pu. (auth)

46064 BETA SPECTRUM OF ^{147}Nd. Nagarajan, T. (Univ. of Madras); Ravindranath, M.; Reddy, K. Venkata. Nuovo Cim.; 3A: No. 4, 689-98(21 Jun 1971).

Even though Beekhuis et al. [Nucl. Phys., 79: 220(1966)] carried out a careful measurement of the shape of 803-keV beta transition, their result is at variance with the recent works reported concurrently with the present measurement. The source material used by Beekhuis et al. was obtained as a fission product that contained numerous interfering activities. The angular-correlation results indicate the validity of the ξ approximation for this transition. The present measurement ($a = -0.17 \pm 0.01$) indicates a breakdown of the ξ approximation, and an admixture of $g_{7/2}$ and $d_{5/2}$ proton orbitals to the 91-keV level of ^{147}Pm is found necessary to explain the present measurement. A strong attenuation of angular correlation by internal fields due to the finite lifetime of the 91-keV level has been reported by Bodenstedt et al. [Zeit. Phys., 160: 33(1960)] in liquid sources. A correction due to this effect and a measurement of energy and angle dependence of circular polarization will be helpful in eliciting further information about this transition. (auth)

46065 LIFETIMES OF EXCITED STATES IN ^{115}In USING A Ge(Li) DETECTOR. Svensson, I. G. (Virginia Polytechnic Inst., Blacksburg); Nainan, T. D.; Hege, E. K. Nuovo Cim.; 3A: No. 4, 680-8(21 Jun 1971).

The half-lives of excited states in ^{115}In at 829 and 864 keV were measured by the method of delayed coincidence between β radiation, detected by a plastic scintillator, and the corresponding γ radiation, detected by a high-resolution Ge(Li) detector. A half-life of (5.78 ± 0.06) ns is uniquely assigned to the 829-keV level, and one of (0.91 ± 0.03) ns, to the 864-keV level, on the basis of three methods of data analysis. (auth)

46066 HYPERFINE INTERACTION IN POLYCRYSTALLINE PARAMAGNETIC YTTERBIUM OXIDE STUDIED BY THE MOESSBAUER EFFECT. Plingen, K.-G.; Wolbeck, B.; Schroeder, F.-J. (Univ., Bonn). Nucl. Phys.; A165: 97-117(1971).

The isotopes of ^{170,171,172,174}Yb were used to study the hyperfine interaction in polycrystalline paramagnetic Yb_2O_3 between 2.5°K and 77.3°K. Asymmetric quadrupole, as well as magnetic dipole interactions, were established for the two different lattice sites, which exist in the sesquioxides. A temperature dependence of the magnetic hyperfine field was observed, whereas a temperature dependence of the electric field gradient could not be detected. The hyperfine interactions are discussed by using electronic wave functions which one can derive from first order perturbation theory. Experimental and theoretical results are compared. By using the identical absorber for all measurements the ratio of the quadrupole moments of the first excited states has been determined with high accuracy. (auth)

46067 QUADRUPOLE INTERACTION OF Hf IN HAFNIUM METAL SINGLE CRYSTALS AFTER RECOIL IMPLANTATION. Guenther, C.; Skaali, B.; Bauer, R.; Herskind, B. (Univ. of Copenhagen). Nucl. Phys.; A164: 321-39(1971).

The quadrupole interaction of the first 2^+ states of ^{178,180}Hf, implanted into a hafnium metal single crystal by 45 and 56 MeV ^{16}O ions and 15 MeV α particles, was studied by the perturbed angular correlation after Coulomb excitation. A static quadrupole interaction has been observed. A comparison with previous Mössbauer experiments suggests the presence of spatial field gradient distributions due to radiation damage caused by the recoiling ions. (auth)

46068 POLARIZATION OF NEUTRONS IN THE (d,d) REACTION. Morozov, V. M.; Gorlov, G. V.; Zubov, Yu. G.; Lebe-

XUM

deva, N. S. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 15-16(Jan 1971). (In Russian).

Polarization of neutrons emitted in (d,d) reaction at the angle of 37° in lab. system was measured at 4 values of the deuteron energy: 1.2, 2.0, 2.4, and 2.7 MeV. In contrast to all the preceding work on the polarization, where He nuclei were used as the polarization analyzer, the present work has used the small-angle elastic scattering of neutrons on Pb and U nuclei (the Schwinger polarization mechanism) to analyze the neutron polarization. The data obtained are in reasonable agreement with the data situated on the upper curve for the polarization in the (d,d) reaction. (auth)

46069 STUDY OF THE ^{242}Pu(d,t)^{241}Pu AND ^{242}Pu(^{3}He,α)^{241}Pu REACTIONS. Elze, Th. W.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Phys. Rev., C; 3: 234-40(Jan 1971).

Energy levels of ^{241}Pu have been studied through the ^{242}Pu(d,t) and ^{242}Pu(^{3}He,α) reactions induced by 17-MeV deuterons and 30-MeV ^{3}He particles, respectively. Transferred orbital angular momenta are obtained from (^{3}He,α) angular distributions and from cross-section ratios R = dσ(^{3}He,α)/dσ(d,t). The ratios R vary by a factor of 10^{3} for a change in l from 0 to 7 and provide a very sensitive measure of the angular momentum transfer. Experimentally measured spectroscopic factors are found to be in reasonable agreement with those calculated from Nilsson wave functions. Rotational bands associated with the following Nilsson configurations are identified in ^{241}Pu: $5/2^{+}[622]$, $7/2^{+}[624]$, $1/2^{+}[631]$, $7/2^{-}[743]$, $3/2^{+}[631]$, $1/2^{-}[501]$, and $5/2^{-}[752]$. (auth)

46070 SYSTEMATICS OF CAPTURE CROSS SECTIONS OF FAST NEUTRONS. Colditz, J.; Hille, P. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Anz.; No. 9, 1-5(1969). (In German).

The capture cross sections of ^{87}Rb, ^{141}Pr, and ^{208}Pb were measured at a neutron energy of 2.9 ± 0.2 MeV. The radiation widths were calculated and were larger by a factor of 2.5 to 5 larger than the values found by previous investigators. An attempt was made to find a formulation in which each nucleus was assigned clearly one cross section. (J.S.R.)

46071 ON-LINE SPECTROSCOPY OF ^{134m}gI. Achterberg, E.; de Aisenberg, E. Y.; Iglesias, F. C.; (and others) (Comision National de Energia Atomica, Buenos Aires). Phys. Rev., C; 4: No. 1, 188-95(Jul 1971).

Sources of mass-134 iodine were produced in ^{235}U fission and studied on line in the Buenos Aires Isotope Separator On Line project using Ge(Li) and Si(Li) detectors. A transition of 272.2 ± 0.3 keV, with $T_{1/2}$ = 3.56 ± 0.08 min, α_K = 0.20 ± 0.03, and K/L+... = 2.6 ± 0.3, thus E3(+≤1% M4) in character, was determined to be the transition depopulating the isomeric state in ^{134}I($E_L - E_K$ = 28.4 ± 0.2 keV and K binding energy = 32.9 ± 0.6 keV). The β branching from this isomeric state to levels of ^{134}Xe amounts to (8 ± 6)%. The γ-ray intensities following the ground-state decay of ^{134}I($T_{1/2}$ = 53.2 ± 0.2 min) are given. Internal-conversion coefficients for 11 transitions were measured ($10^{4}\alpha_K$): 135 keV, 2600 ± 500; 188 keV, 1300 ± 500; 236 keV, 700 ± 100; 406 keV, 110 ± 20; 433 keV, 150 ± 30; 541 keV, 60 ± 8; 596 keV, 70 ± 8; 622 keV, 52 ± 8; 628 keV, 25 ± 19; 847 keV, 18 ± 3; and 884 keV, 19 ± 4. Parities and angular momenta for levels of ^{134}Xe are proposed. (auth)

46072 STUDY OF THE ZIRCONIUM ISOTOPES WITH THE (p,t) REACTION. Ball, J. B. (Oak Ridge National Lab., Tenn.); Auble, R. L.; Roos, P. G. Phys. Rev., C; 4: No. 1, 196-214 (Jul 1971).

The (p,t) reaction was studied on all stable isotopes of zirconium at a proton energy of 38 MeV. Triton spectra were analyzed with a magnetic spectrograph yielding over-all resolution on the order of 25 keV. Comparison of experimental angular distributions with two-nucleon transfer distorted-wave Born-approximation calculations is made to extract spin-parity assignments and transition enhancement factors for many of the observed levels. The observed L = 0 transitions are discussed in terms of the shell model and the pairing-vibration model. The levels observed in ^{88,89,90,92,94}Zr are compared with results of other experiments to derive a number of new level assignments. Measurements are also obtained of the one- and two-neutron binding energies from Q values deduced for the (p,t) and (p,d) ground-state transfer reactions. (auth)

46073 RADIOACTIVE DECAY OF 23-MIN ^{131}Sb TO LEVELS OF ^{131}Te. Blachot, J. (Massachusetts Inst. of Tech., Cambridge); Erten, H. N.; Coryell, C. D.; Macias, E. S.; Walters, W. B. Contract AT(30-1)-905. Phys. Rev., C; 4: No. 1, 214-20 (Jul 1971).

The levels of ^{131}Te were investigated by studying the γ rays following the β decay of 23-min ^{131}Sb using Ge(Li) detectors. The ^{131}Sb sources were produced by rapid separation of Sb from ^{235}U thermal-neutron-fission products. The 60 γ rays attributed to ^{131}Sb decay were observed, and γ-γ coincidence relations were obtained for the prominent lines. A level scheme was constructed which incorporates 40 of these γ transitions between 23 levels in ^{131}Te. This level scheme is compared with the level structure of other odd-A Te isotopes and is discussed within the framework of the pairing-plus-quadrupole model. (auth)

46074 SUBTHRESHOLD NEUTRON-INDUCED FISSION IN ^{238}U. Silbert, M. G.; Bergen, D. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 4: No. 1, 220-3(Jul 1971).

In an attempt to observe subthreshold fission in ^{238}U, a sample with very low ^{235}U content was exposed to the intense neutron beam of the Physics-8 nuclear explosion. A high-sensitivity oscilloscope setting allowed individual fission-fragment pulses from a semiconductor detector to be counted. In the region from 37 to 327 eV, the average fission width for eight resonances was determined to be (0.03 ± 0.05) × 10^{-6} eV. In the keV region, the average fission cross section was measured to be 61 ± 24 μb from 10^{4} to 3 × 10^{4} eV and 36 ± 14 μb from 3 × 10^{4} to 10^{5} eV. (auth)

46075 IMPORTANCE OF EXCITATION FUNCTIONS IN FAST NEUTRON FLUX MEASUREMENT. Crumpton, D.; Francois, P. E.; Hunt, S. E. (Univ. of Aston, Birmingham, Eng.). Nucl. Instrum. Methods; 92: No. 4, 533-6(1971).

From Symposium on the use of low energy accelerators; London, England (27 May 1970). See CONF-700563.

The importance of a knowledge of the excitation function of reactions used as monitors for 14-MeV flux measurements is discussed. The information on excitation functions of frequently used reactions is summarized, and some new measurements are reported. (38 references) (auth)

46076 SOME LIMITATIONS ON THE PRODUCTION OF VERY NEUTRON-DEFICIENT NUCLEI. Stephens, F. S.; Leigh, J. R.; Diamond, R. M. (Univ. of California, Berkeley). Nucl. Phys.; A170: No. 2, 321-35(1971).

The present method of producing very-neutron-deficient nuclei, evaporation of neutrons following compound nucleus formation, is limited by the eventual predominance of protons over neutrons in the evaporation spectrum. Measurements were made to determine the effective Coulomb barrier for protons in the evaporation process, and the nature and location of this limit was explored mathematically. (auth)

46077 MULTIPOLE CHARACTER OF SOME GAMMA TRANSITIONS IN ^{152}Sm. Helppi, H.; Hattula, J. (Univ. of Jyvaeskylae, Finland). Phys. Scr.; 2: No. 4-5, 155-8(1970).

Multipole character of some transitions connecting the quadrupole and octupole vibrational bands to the ground-state rotational band in ^{152}Sm have been determined by measuring directional correlations using a Ge(Li)-NaI(Tl) spectrometer. A total of 14 correlations have been measured. From these measurements it can be concluded that the $2_\beta^+ - 2^+$, 689 keV, $2_\gamma^+ - 2^+$, 964 keV and $3_1^+ - 2^+$, 1,112 keV transitions are essentially pure E2, and $3^- - 2_\gamma^+$, 1,457 keV, $3^- - 4^+$, 1,213 keV and $2^- - 2^+$, 1,408 keV transitions contain less than 2% M2. (auth) (Sweden)

46078 BETA DECAY OF ^{220}Fr. Briand, J. P.; Chevallier, P.; Touati, A. (Univ., Paris). J. Phys. (Paris); 32: No. 2-3, 101-5(Feb-Mar 1971). (In French).

A very weak (3.5×10^{-3})β^- branch in the disintegration of ^{220}Fr ($T_{1/2}$ = 25 s) is observed using special techniques of collection of α recoil atoms of various order. This result implies J = 1+ for the fundamental level of ^{220}Fr. The observation in α spectra of ^{224}Ac samples of an α ray at 7.960 MeV, is explained by the hypothesis of an isomeric state either in ^{216}At, or in ^{212}Bi. (auth) (France)

46079 STUDY OF THE SPINS OF ^{227}Ac LEVELS BY α-γ ANGULAR CORRELATION (^{231}Pa → ^{227}Ac). Leang, Chin Fan (CNRS, Orsay, France). J. Phys. (Paris); 32: No. 2-3, 95-9 (Feb-Mar 1971). (In French).

By means of a multidimensional coincidence method, with registration on magnetic tape and analysis on an IBM computer, the α-γ angular correlation study of ^{231}Pa confirms spins assignment of the first three excited levels of ^{227}Ac ($3/2^+$, $5/2^-$, $5/2^+$). For the ground state $3/2^-$, the results are only in agreement with a mixing (M_1 > 95%, E_2 < 5%) of the 330 keV transition. (auth) (France)

46080 DERIVATION OF THE VIBRATIONAL-ROTATIONAL INTERACTION PARAMETERS IN ^{228}Th. Ardisson, G. (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. B; 272: No. 14, 867-70(5 Apr 1971). (In French).

The calculation of the branching ratios for the E2 transitions

from the K = 2 band to the ground state band of ^{228}Th enables the Z_γ mixing parameter to be determined ($Z_\gamma = 0.04 \pm 0.0056$). When a $\beta-\gamma$ interaction is considered, the consistency of the various values of Z_γ obtained is improved and the value of the $\beta-\gamma$ coupling parameter can be derived: $Z\beta\gamma = -(0.020 \pm 0.006)$. (France)

46081 K X-RAY AND GAMMA-RAY ANGULAR CORRELATIONS IN THE DECAY OF ^{113}Sn AND ^{133}Ba, USING A HIGH EFFICIENCY SUM-PEAK COINCIDENCE SCINTILLATION SPECTROMETER. Rao, K. Venkata Rama; Lakshminarayana, V. (Andhra Univ., Waltair, India). Can. J. Phys.; 49: 1769-72(1 Jul 1971).

K-capture isotopes ^{113}Sn and ^{133}Ba are used with a sum-peak coincidence scintillation spectrometer arrangement to study the K x-ray–gamma-ray angular correlation. The effects of the type of beta decay, the nuclear environment, and three-gamma cascades with intermediate gamma ray unobserved are investigated. No anisotropy could be detected, supporting the theory of Dolginov. (auth) (Canada)

46082 ON MASS-YIELD OF XENON AND KRYPTON ISOTOPES IN THE SPONTANEOUS FISSION OF URANIUM. Sabu, D. D. (Grambling Coll., La.). J. Inorg. Nucl. Chem.; 33: 1509-13(May 1971).

Mass spectrometric measurements of xenon and krypton isotopes in uranium minerals were used for accurate estimation of fission yields of stable isotopes of these elements in the spontaneous fission of ^{238}U. The relative yields of ^{136}Xe : ^{134}Xe : ^{132}Xe : ^{131}Xe : ^{129}Xe : ^{86}Kr : ^{84}Kr : ^{83}Kr are respectively 6.00 : 4.99 ± 0.01 : 3.48 ± 0.02 : 0.65 ± 0.03 : 0.03 ± 0.01 : 1.10 ± 0.05 : 0.24 ± 0.05 : 0.07 ± 0.02. (auth) (UK)

46083 STUDY OF THE ^{111}Sn DECAY. Rivier, Janine; Moret, Roger (Univ., Grenoble, France). Compt. Rend., Ser. B; 272: No. 17, 1022-5(26 Apr 1971). (In French).

Various experimental techniques (scintillation and semiconductor gamma spectrometers, coincidence methods) were used to study the ^{111}Sn decay. The value of the EC/β^+ ratio for the branch leading to the ground state, and the decay scheme are given. (France)

46084 DETERMINATION OF THE DECAY CONSTANT FOR SPONTANEOUS FISSION OF NATURAL URANIUM USING FISSION TRACK ACCUMULATION. Kleeman, J. D.; Lovering, J. F. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta; 35: No. 6, 637-40(Jun 1971).

The decay constant for spontaneous fission of natural uranium was determined by accumulating fission fragment tracks in Lexan plastic held adjacent to uranium metal for one year. The value, $6.8 \pm 0.6 \cdot 10^{-17}$ yr^{-1}, is consistent with values most commonly used in fission track dating. (auth) (UK)

46085 HALF-LIVES OF ^{245}Cm, ^{246}Cm, AND ^{248}Cm. MacMurdo, K. W.; Harbour, R. M.; Benjamin, R. W. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem.; 33: 1241-7(May 1971).

The partial alpha decay half-lives of ^{245}Cm, ^{246}Cm, and ^{248}Cm were determined by a relative specific activity technique with ^{244}Cm as a reference, and were found to be 8532 ± 53 yr, 4820 ± 20 yr, and $(3.94 \pm 0.04) \cdot 10^5$ yr, respectively. Partial spontaneous fission half-lives of $(1.85 \pm 0.02) \cdot 10^7$ yr and $(4.20 \pm 0.05) \cdot 10^6$ yr were determined for ^{246}Cm and ^{248}Cm, respectively, by plastic fission-track recorder, surface barrier detector, and 2π fission chamber methods. (auth) (UK)

46086 CALORIMETRIC DETERMINATION OF THE HALF-LIVES OF ^{228}Th AND ^{224}Ra. Jordan, K. C.; Otto, G. W.; Ratay, R. P. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 33: 1215-19(May 1971).

^{228}Th prepared by second-order neutron capture was recovered from ^{226}Ra irradiated in a nuclear reactor. The sample was studied by calorimetry for approximately 3400 days, then opened to permit analysis of the contents. A least-squares analysis of the data gave a half-life value of 1.91313 ± 0.00088 yr for ^{228}Th. In addition, the data gave 3.665 ± 0.038 days (probable error) as the half-life of ^{224}Ra, the daughter of ^{228}Th. (auth) (UK)

46087 ENHANCED LOW-ENERGY E2 TRANSITIONS IN THE ODD-A ISOTOPES OF Sb, I, Cs, AND Pr. Goldstein, I. V.; de Pinho, A. G. (Pontificia Univ. Catolica, Rio de Janeiro). Can. J. Phys.; 49: 1794-7(1 Jul 1971).

The intermediate coupling version of the unified model was used to calculate E2 transition rates in some odd-mass isotopes of Sb, I, Cs, and Pr. The observed enhancement of these transitions is reproduced and regular variations of the transition probabilities in groups of neighboring isotopes are explained. (auth) (Canada)

46088 ISOMERIC STATE OF ^{97}Rh. Lopez, A. M.; Prestwich, W. V.; Arad, B. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: 1828-32(1 Jul 1971).

Radioactive ^{97}Rh was produced via the ^{96}Ru(p,γ)^{97}Rh reaction. The two most intense lines in the γ-ray spectrum of ^{97}Rh, at 190 and 421 keV, were observed to decay with half-lives of 40 ± 2 and 30 ± 2 min respectively. This result is interpreted as evidence for a 30 min isomeric state in ^{97}Rh. The interpretation is further supported by the observation of the 19 keV Rh K_α x ray. With this interpretation it is possible to resolve a discrepancy in the observations of previous investigators as regards the relative intensity of the 190 and 421 keV transitions. (auth) (Canada)

46089 NUCLEAR CHARGE DISPERSION IN THE FISSION OF ^{235}U BY PROTONS OF ENERGY 20 TO 85 MeV. Saha, G. B.; Tomita, I.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem.; 49: 2205-16(1 Jul 1971).

Independent formation cross sections of ^{129}Cs, ^{130}Cs, ^{131}Cs, ^{134m}Cs, $^{134m+g}$Cs, ^{136}Cs, ^{130}Ce, and cumulative formation cross sections of ^{141}Ce and ^{143}Ce were obtained when ^{235}U was caused to fission with protons of energies varying between 20 and 85 MeV. The energies at which the excitation functions reached their maxima were related to the neutron-to-proton ratio of the fission products. These were compared with other fissioning systems. Charge dispersion curves were obtained from the cross section data. The variation of $(Z_A - Z_p)$ with energy, both in magnitude and in trend, agrees extremely well with predictions made by Saha and Yaffe for nuclides in this mass range. Calculations for Z_p show that good agreement is obtained with the unchanged charge division hypothesis. An estimate was made of the total number of neutrons emitted in fission at these energies. (auth) (Canada)

46090 STUDY OF THE γ RADIATION FOLLOWING THE DECAY OF Ms Th II (^{228}Ac). Dalmasso, Josette; Maria, Henriette (Univ., Nice). Compt. Rend., Ser. B; 272: No. 15, 905-8 (14 Apr 1971). (In French).

The gamma radiation of ^{228}Ra and its daughter products was studied with a high resolution coaxial Ge(Li) detector. The intensities of 156 transitions were determined; 32 were found for the first time. (auth)

46091 GAMMA-RAY LINES FROM (n,2n) AND (n,n') REACTION IN RADIOGENIC AND NATURAL LEAD. Joensson, Bodil (Lund Univ., Sweden). Phys. Scr.; 2: No. 6, 277-81 (1970).

Discrete γ-ray lines emitted after (n,2n) and (n,n') reactions in radiogenic and natural lead at 15.5 MeV neutron energy have been studied. Differential 120° cross sections have been determined relative to the cross section for the ground state transition from the 4.44 MeV level of ^{12}C populated through inelastic scattering. The (n,2n) and (n,n') contributions to the cross sections for the most dominant γ-ray lines in ^{206}Pb have been separated. Upper and lower limits of the cross sections for (n,2n) and (n,n') reactions in lead are estimated. The results indicate that the statistical theory of nuclear reactions fails to give a correct description of neutron emission processes in lead at 15 MeV neutron energy. (auth) (Sweden)

46092 MAGNETIC MOMENTS AND MIXING RATIOS IN THE γ-DECAY OF ^{125}Te. Rots, M.; Silverans, R.; Coussement, R. (Univ., Louvain, Belg.). Nucl. Phys.; A170: No. 2, 240-52(1971).

Angular correlations in the γ-decay of ^{125}Te have been investigated with a Ge(Li) and NaI(Tl) detector combination. The results for the character of the observed transitions are: two pure M1 transitions (172 and 209 keV), two pure E1 transitions (117 and 320 keV), one pure E2 transition (379 keV) and finally one mixed transition (204 keV), $-1.36 < \delta(E2/M1) < -0.47$. Moreover two magnetic moments $\mu_{\frac{3}{2}-} = -(0.66 \pm 0.09)$ n.m. (321 keV state), $\mu_{\frac{3}{2}+} = +(0.79 \pm 0.30)$ n.m. (463 keV state) and the precession angle $\omega\tau = +0.107 \pm 0.024$ rad for the 525 keV state are determined. All these data, together with the results of Coulomb excitation and (d,p) reaction work, are used to explain the level structure in the ^{125}Te decay scheme. The experimental results are compared with the predictions of the Kisslinger–Sorensen calculations and a striking agreement is found. Comments are also made about the experimental conditions of the earlier measurements of the anticipated three quasi particles state at an excitation energy of 321 keV. (auth)

46093 ANGULAR AND ENERGY DISTRIBUTIONS OF α-PARTICLES IN LRA FISSION. Vitta, P. B. (Emory Univ., Atlanta). Nucl. Phys.; A170: No. 2, 417-38(1971).

Detailed experimental studies have been made on the angular and energy distributions of the long-range α-particles (LRA) emitted from ^{252}Cf during spontaneous fission. They show that

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the α-particle angular distribution is peaked at an angle (made by the trajectory of the α-particle with that of either of the main fragments) of about 90° and has a FWHM of 20–30. The α-particle energy spectrum is peaked at about 15 MeV and has a FWHM of 13 MeV. Computer calculations of the trajectories of the three particles produced in LRA fission were performed. Such calculations lead to predictions of angular and energy distributions which may be compared with the experimental ones. The calculations were carried out using a set of initial conditions determined by the statistical theory of nuclear fission. The comparison with experimental results therefore provides a test of the statistical theory. The calculated results show that the statistical theory leads to an energy spectrum which is in good agreement with the experimental one, and that reasonable agreement between the calculated and the experimental angular distribution may be obtained if it is assumed that the α-particle is emitted within a short period of time, of the order of 3×10^{-22} s after the instant of scission. (auth)

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Refer also to abstracts 45727, 45823, 46003, and 46076.

46094 (BNL-tr-417) ON THE CORRELATION BETWEEN THE REDUCED NEUTRON WIDTHS AND PARTIAL RADIATION WIDTHS IN RESONANCES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P4-5583. 10p. Dep. NTIS.

The wave functions of the excited states and the transition matrix elements are used to determine in what instances correlations occur between the reduced neutron widths and partial radiative widths of neutron resonances. (J.W.R.)

46095 (EANDC-87-U) TECHNICAL MINUTES OF THE FOURTEENTH MEETING OF THE COMMITTEE, ARGONNE NATIONAL LABORATORY, USA, 26–29 OCTOBER 1970. Hanna, G. C. (comp.) (European-American Nuclear Data Committee). 27p. Dep. NTIS (U. S. Sales Only).

Highlights of the meeting include work on reference cross sections and flux measurements as well as progress reports and research papers. The body of the report is divided into the following sections: reports on facilities and measurements; EANDC symposium on standards; nuclear data for safeguards, fusion, and medical applications; conferences; request list; and data indexing, compiling, and evaluation. (R.W.R.)

46096 (JAERI-13559) STATISTICAL INFERENCE OF RESONANCE PARAMETERS AND NEUTRON STRENGTH FUNCTION. Tomioka, Hidetake Y. (Japan Atomic Energy Research Inst., Tokai). May 1969. 19p. NTIS (U. S. Sales Only).

A method is set up to estimate the statistics of resonance parameters and neutron strength function in the statistical theory of compound-nucleus reactions. The resonance parameters considered are reduced neutron width $\Gamma n^{(0)}$, radiation width $\Gamma\gamma$, and level spacing D. The sample probability density function of neutron strength function is derived exactly, and the method of interval estimation is used for the statistical estimation of the variance. A code for statistical inference of resonance parameters and neutron strength function is made on the basis of this method. The output of the code is used as the input to FPCROS. (auth) (Japan)

46097 (RT/EL-(69)7, Paper 1) ORGANIZATION OF ELECTRONICS IN CNEN, ITALY. GENERAL DESCRIPTION AND REVIEW OF THE ACTIVITIES PERFORMED AND THE PROGRAMS IN DEVELOPMENT. Rispoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 46p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

The organization and structure of the Italian National Committee for Nuclear Energy (CNEN) is explained. CNEN is active in the areas of reactors, applied nuclear research, nuclear physics, and radiation; in addition, it contains a coordination unit for electronics and instrumentation. The various activities carried out at installations at Casaccia, Frascati, Bologna, Trisaia, and Saluggia are described. The principal technological programs of CNEN are the following: CIRENE (Heavy Water Reactor Program), the ship propulsion programs, EUREX (plant for the reprocessing of highly enriched uranium fuel elements), the plutonium program, and the fast reactor program. The research program in electronics and automation is concerned with the detection of ionizing radiation and automation of nuclear processes and experiments. (R.W.R.)

46098 NONLOCALITIES IN NUCLEAR OPTICAL-MODEL POTENTIALS. Arnold, Louis G. (Ohio State Univ., Columbus). Phys. Rev. Lett.; 26: No. 20, 1263-6(17 May 1971).

The energy dependence and surface geometry of an optical-model equation with a nonlocal potential are compared with corresponding properties of optical-model equations with local and velocity-dependent potentials that are used to generate approximate solutions to the nonlocal-potential equation. (auth)

46099 SEPARATION OF THE CENTER-OF-MASS MOTION IN THE NUCLEAR MANY-BODY PROBLEM. PSEUDOMETRIC. Miglietta, F. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim.; 4A: No. 1, 144-155(1 Jul 1971).

It is emphasized that the usual treatment of the relative motion of N nucleons in a nucleus by means of a wave function depending on 3N space co-ordinates, instead of 3N−3, imposes the introduction of a pseudometric in the Hilbert space of states of the system. An analysis of what is correct and what is not in the usual nuclear theory, which ignores the existence of the pseudometric, is presented. (auth)

46100 STATISTICAL MODELS FOR HEAVY NUCLEI. Arnold, L. (Univ., Stuttgart); Schassberger, R. Nuovo Cim.; 4A: No. 1, 99-110(1 Jul 1971).

A general statistical model (L,U,P) for heavy nuclei is presented, where L is a set of self-adjoint operators, U a group of unitary operators acting via $H \to UHU^{-1}$ ($H \in L$, $U \in U$) as transformation group in L, and P a probability measure on L which is invariant with respect to U. Wigner's model is discussed and criticized. A survey of all invariant probability measures for the case of locally compact and compact L is given. Two new models (a finite-dimensional and a Hilbert-space model) avoiding the disadvantages of the models treated so far are presented. (auth)

46101 EFFECT OF CORRELATIONS ON THE THREE-BODY FORCES TO THE BINDING ENERGY OF NUCLEAR MATTER. McKellar, Bruce H. J. (Univ. of Sydney); Rajaraman, R. Phys. Rev., C; 3: No. 5, 1877-86(May 1971).

The contribution of three-body forces to the binding energy of nuclear matter, including the effects of two- and three-body correlations induced by the two-nucleon forces is investigated, and it is found that it may be approximated by using plane-wave three-nucleon states cut off when any interparticle distance is less than about 0.9 fm. Existing calculations can then be used to estimate that three-body forces contribute about 1 MeV to the binding energy. (auth)

46102 HOLE-LINE EXPANSION FOR NUCLEAR MATTER. Schucan, Thomas H.; Weidenmueller, Hans A. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Rev., C; 3: No. 5, 1856-66(May 1971).

The ground-state energy of nuclear matter is expanded in such a way that each term of the expansion is characterized by the number of hole lines. This procedure reverses the usual sequence of steps, which consists in the use of the linked-cluster theorem, the introduction of G matrices, and the partial summation of G-matrix diagrams leading to the hole-line expansion. In this way, an algebraic method is found which yields automatically all diagrams with a fixed number of independent hole lines. As a by-product, a new proof for the linked-cluster theorem is obtained. The method was applied to diagrams with four independent hole lines and complete agreement with results published previously by B. D. Day was found. (auth)

46103 THREE-FLUID HYDRODYNAMICAL MODEL OF NUCLEI. Mohan, Radhe (Duke Univ., Durham, N. C. Rutgers-The State Univ., New Brunswick, N. J.); Danos, M.; Biedenharn, L. C. Phys. Rev., C; 3: No. 5, 1740-9(May 1971).

A three-fluid model of nuclei is introduced, the three fluids being the protons, the neutrons of the same orbitals as protons, and the excess neutrons, to account for the fact that the excess neutrons interact less strongly with the protons than do the neutrons which occupy the same space-spin states as the protons. Calculations of proton and neutron density distributions, of isotope shifts, and of isospin impurities have been carried out. The giant-dipole phenomenon is also studied in the present model. It is found that considerable improvement is achieved in the results for the proton density distribution and for the isospin impurities as compared with the two-fluid model. The other results are found to be consistent with previous calculations. (auth)

46104 STRONG-INTERACTION EFFECTS IN K-MESONIC ATOMS. Bardeen, William A.; Torigoe, E. Wayne (Stanford Univ., Calif). Phys. Rev., C; 3: No. 5, 1785-97(May 1971).

The process of absorption in K-mesonic atoms is studied with special emphasis on the role of the $Y_0^*(1405)$ resonance. An effective t-matrix method is developed to incorporate the effects of the resonance. Detailed calculations of the absorption process, based on an independent-particle model of the nucleus, were made for selected nuclei. The results of these calculations are compared with available x-ray and emulsion data for moderate to heavy nuclei. (auth)

46105 MECHANISM AND RATE OF LONG-RANGE α-PARTICLE EMISSION IN FISSION. Fong, Peter (Emory Univ., Atlanta). Phys. Rev., C; 3: No. 5, 2025-7(May 1971).

The statistical theory of fission has been used in previous works to calculate the energy and angular distributions of the long-range α particle emitted in fission. It is now applied to calculate the probability of long-range α-particle-accompanied fission relative to binary fission. For thermal-neutron fission of ^{235}U the calculated rate is 1 α-particle-accompanied fission in 461 binary fissions, which agrees well with the experimental value of 1 in 449. Concerning the mechanism, the large amount of energy required (more than 24 MeV) to emit an α particle at the scission point comes mainly from the reduction of the Coulomb energy between the main fragments through an over-stretched form of deformation. The balance of energy shows that the total excitation energy in α-particle-accompanied fission is reduced by about 4.5 MeV compared with binary fission. According to the statistical theory this reduces the relative probability by several hundred fold. (auth)

46106 PRECOMPOUND DECAY FROM A TIME-DEPENDENT POINT OF VIEW. Harp, G. D.; Miller, J. M. (Columbia Univ., New York). Phys. Rev., C; 3: No. 5, 1847-55(May 1971).

A model is proposed for following the progress of nucleon-induced nuclear reactions as a function of time. It predicts that the majority of protons and high-energy neutrons emitted from heavy targets in these reactions appear before internal statistical equilibrium has been established. However, for the 18-MeV (p,xn) reaction with ^{181}Ta the model predicts fewer high-energy neutrons than are observed experimentally. Further, there is a difference in shape between the predicted and observed spectrum. The same differences arise when a comparison is made between the experimental spectrum and that predicted by Griffin's model for decay. It is suggested that these differences arise because both models fail to consider surface reactions explicitly. It is also suggested that this model might best be used in conjunction with Monte Carlo cascade calculations of high-energy nuclear reactions to follow the complete equilibration of the nonequilibrated excited nuclei left after these cascades are terminated. An example of using the model for this purpose is given. (auth)

46107 APPLICATION OF THE MARUMORI BOSON EXPANSION TO THE PROBLEM OF PARTICLE-HOLE EXCITATION IN CLOSED-SHELL NUCLEI. Li, Shou Yung; Klein, Abraham (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 3: No. 5, 1871-6(May 1971).

Marumori's boson-expansion method is applied to the problem of particle-hole excitation in closed-shell nuclei. It is shown that consistent (and in principle, straightforward) calculations yield correct results for the ground-state correlation energy, occupation probabilities, and the lowest-order random-phase approximation. A method introducing higher-order random-phase approximations based on the transformation of Rowe's formulation in particle-hole space is described. (auth)

46108 TESTS FOR SECOND-CLASS CURRENTS IN NUCLEAR BETA DECAY. Holstein, Barry R.; Trieman, S. B. (Princeton Univ., N. J.). Phys. Rev., C; 3: No. 5, 1921-6(May 1971).

Semileptonic interactions with anomalous, i.e., "second-class," G-parity properties are uniquely correlated with certain characteristic terms in the amplitude for β decay between members of a common isotopic multiplet. The observational effects associated with second-class currents are worked out for several features of the β-decay spectrum as well as for $\beta-\gamma$ correlation phenomena. (auth)

46109 SIMPLE MOMENTUM-DEPENDENT NUCLEAR CENTRAL POTENTIAL. Chasman, R. R. (Argonne National Lab., Ill.). Phys. Rev., C; 3: No. 5, 1803-7(May 1971).

A momentum-dependent potential is developed to generate nuclear single-particle spectra in agreement with experiment. The parameters of the model are obtained by fitting to experimental data on nuclides with masses greater than 160. The heavy-element neutron single-particle spectrum is compared with the spectrum generated from a Woods-Saxon potential. The potential is applied to the problem of computing the single-particle spectra of nuclides in the mass-300 region. (auth)

46110 DISTRIBUTION OF INTENSITIES OF THERMAL-NEUTRON-CAPTURE GAMMA RAYS. Bollinger, Lowell M. (Argonne National Lab., Ill.). Phys. Rev., C; 3: No. 5, 2071-2(May 1971).

The distribution of the intensities of thermal-neutron-capture γ rays is discussed within the framework of the statistical model. It is shown that if initial states of only one spin and parity are involved, the γ-ray intensities for most nuclides approximately satisfy the Porter-Thomas distribution, independent of how many resonances contribute to the thermal-neutron-capture cross section. (auth)

46111 NOTE ON SHORT-RANGE CORRELATIONS AND ELASTIC ELECTRON SCATTERING. Fink, M.; Hebach, H.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Phys. Rev., C; 3: No. 5, 2075-6(May 1971).

It is proved exactly that short-range correlations enter into diagonal matrix elements of any one-body operator only in 2nd and higher order if the single-particle wave functions have been chosen self-consistently as solutions of the Hartree–Fock equations. Deviations between experimental and theoretical single-particle form factors for elastic electron scattering due to short-range correlations cannot be described by the usual Jastrow functions and generally are much smaller than hitherto assumed. (auth)

46112 JOSEPHSON EFFECT IN NUCLEAR REACTIONS. Kleber, Manfred; Schmidt, Hartwig (Technische Univ., Munich). Z. Phys.; 245: No. 1, 68-80(1971).

The transfer of Cooper pairs during the scattering of two superfluid nuclei just below the Coulomb barrier is discussed on a phenomenological and a microscopic level. This transfer is analogous to the Josephson current between two superconductors. Candidates for the observation of such an effect are heavy ions with a small difference in mass number. Numerical estimates are presented. (auth)

46113 OPTICAL-MODEL POTENTIAL AND RPA IN THE CONTINUUM. Cugnon, J. (Univ., Liege). Z. Phys.; 245: No. 1, 55-67(1971).

The optical-model potential for nucleon-nucleus scattering is constructed theoretically in the framework of the RPA. Inelastic channels and resonant states contributions to the imaginary part differ from the TDA case. The origin of this difference is qualitatively discussed. A small background term is added to the real part. (auth)

46114 COHERENCE PROPERTIES OF TWO-NEUTRON TRANSFER REACTIONS AND THEIR RELATION TO INELASTIC SCATTERING. Broglia, R. A. (Univ. of Copenhagen); Riedel, C.; Udagawa, T. Nucl. Phys.; A169: No. 2, 225-38 (1971).

The correlation aspects of two-neutron transfer and inelastic scattering reactions are discussed from a unified point of view. The experimentally observed correlations between the two types of collective states and corresponding cross sections are qualitatively explained. (auth)

46115 EFFECTIVE SINGLE-PARTICLE POTENTIAL. Heiss, W. D. (Univ., Heidelberg). Nucl. Phys.; A169: No. 2, 248-56(1971).

In the framework of the independent-particle model, the scattering function for one particle in the continuum and for $n-1$ particles in bound states is studied. An effective single-particle potential is constructed in such a way that the resulting effective single-particle wave function provides the same scattering matrix. The Pauli principle generates a non-local effective potential which behaves like r^{-2} at the origin. Possible physical consequences are discussed. (auth)

46116 ASYMMETRIC DEFORMATION OF FISSIONING NUCLEI. Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A169: No. 2, 275-93(1971).

The potential energy of a nucleus at large (scission) deformation is calculated by the shell-correction method due to Strutinsky. The shape of the nucleus in the zeroth-order approximation is taken to be the Cassinian ovaloid, the deviation being expanded in a series of Legendre polynomials. Asymmetric shapes of the nucleus are studied; a definition of the Woods-Saxon type nuclear potential is given; the single-particle spectrum, shell correction, liquid-drop energy and total potential energy are calculated. It is shown that the transuranium nuclei are symmetric at the first barrier and in the second minimum of the potential energy. The second saddle point is situated at a large asymmetric deformation. The nuclear asymmetry near the scission point is in qualitative agreement with experimental data on the asymmetry in the mass distribution of the fission fragments. The agreement between the theoretical

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results and experimental data on the fission barriers is improved when the asymmetry is taken into account. (auth)

46117 TREATMENT OF RESONANT FINAL STATES IN DIRECT REACTIONS. Berggren, Tore (Inst. of Tech., Lund, Sweden). Nucl. Phys.; A169: No. 2, 353-62(1971).

The total (energy-integrated) contribution from a resonance in the final state of an unobserved particle in a break-up reaction to the differential cross section is calculated in a simple, solvable model. It is found that this contribution can be expressed in terms of matrix elements of the transition operator which are formed using resonant (Gamow) states in the same way as bound states in inelastic scattering. These matrix elements satisfy formal energy conservation in terms of the complex energies of the resonant states. The mathematical structure of the cross-section formula is a non-trivial generalization of the expression used in the case of bound final states. (auth)

46118 VELOCITY DEPENDENCE IN THE POTENTIALS FOR NEUTRON SCATTERING MODELS. Canfield, E. H. (Univ. of California, Livermore); Amster, H. J.; Kasper, R. G.; Mark, Hans. Nucl. Phys.; A169: No. 2, 385-400(1971).

Although static potentials have long been used in nuclear models and reproduce many experimental results remarkably well, they do not satisfy certain physical requirements. It is shown that for single-particle problems at a fixed energy, some static potential will always give the same results as any velocity-dependent potential. Furthermore, if the velocity-dependent potential is assigned a certain type of functional form, including the commonly used one proposed by Woods and Saxon, the equivalent static potential has nearly the same form. Thus, it is very difficult to test for velocity-dependence by means of elastic scattering and energy-level calculations. The effect of velocity-dependence on inelastic scattering is not established analytically, but numerical calculations imply that it would also be extremely difficult to detect. (auth)

46119 PHENOMENOLOGICAL LOCAL SOFT-CORE NUCLEON–NUCLEON POTENTIAL. Eikemeier, H. (Univ., Tuebingen, Ger.); Hackenbroich, H. H. Nucl. Phys.; A169: No. 2, 407-16(1971).

The parameters of a phenomenological local charge-independent soft-core nucleon–nucleon potential with central, spin-orbit and tensor terms were fitted to the experimental data for the four two-nucleon states. The radial dependences are represented by sums of Gaussian functions. A potential for this kind is particularly suited for calculations of nuclear states and reactions because it can be handled easily. Especially, it simplifies calculations in the harmonic oscillator shell model and in the refined cluster model. (auth)

46120 CALCULATION OF THE NUCLEON–NUCLEUS OPTICAL POTENTIAL. Kidwai, H. R.; Rook, J. R. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A169: No. 2, 417-25(1971).

The Greenlees formula is used to calculate the value and energy variation of the real part of the nucleon–nucleus optical potential. Reasonable agreement with potentials obtained from analysis of experimental data is obtained. The validity of the Greenlees formula is discussed and it is shown that it is expected to be satisfactory for bombarding energies less than about 50 MeV. (auth)

46121 NOTE ON ANGULAR MOMENTUM PROJECTION OPERATORS. Corbett, J. O. (Oxford Univ.). Nucl. Phys.; A169: No. 2, 426-8(1971).

It is shown that the operator P^{J}_{MK} is only a projection operator if M = K. The nature and applications of the general form are discussed. (auth)

46122 HIGH-ENERGY DEUTERON PRODUCTION AND NUCLEAR CORRELATION. Futami, Yasuhiko; Miyazima, Tatsuoki (Tokyo Univ., Chiba, Japan. Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 45: No. 3, 776-83(Mar 1971).

High-momentum deuteron production from a nucleus may give information about the short-range nuclear pair correlation. The differential cross section for the process A(p,pd)A−2 is analyzed by using free p–d elastic scattering data. (auth)

46123 HIGHER ORDER EFFECTS IN ALLOWED BETA TRANSITIONS AND THE CONSERVED VECTOR CURRENT THEORY. Dahiya, H. S.; Singh, B. P. (Univ. of Roorkee, India). Progr. Theor. Phys. (Kyoto); 45: No. 3, 975-6(Mar 1971).

The dependence of the angular correlation coefficient for beta and gamma rays on the nuclear structure factor and enhancement factor for beta decay of ^{134}Cs is shown graphically, and the theoretical implications of these results are discussed. (R.W.R.)

46124 TWICE DOUBLE-TRANSFER IN INELASTIC PROTON SCATTERING PROCESSES INVOLVING COLLECTIVE PAIRING STATES, STUDIED IN A COUPLED CHANNELS FORMALISM. Ascuitto, R. J. (Yale Univ., New Haven); Glendenning, Norman K.; Soerensen, Bent. Nucl. Phys.; A170: No. 1, 63-87(1971).

It is argued that the intermediate formation of a triton in (p,p′) processes leading to a pair vibrational state offers an interesting possibility for studying two-step processes involving cluster formation, which is in fact more easily accessible to experimental probing than e.g. processes involving intermediate formation of a deuteron. A strong-coupling microscopic calculation is performed by adding reaction source terms to the proton and triton channel equations for protons on ^{48}Ca and tritons on ^{46}Ca. Comparison is made with ^{48}Ca(p,p′) experiments and in addition the energy dependence of the cross sections is studied. Possible systematic trends are indicated which may be useful in connection with further experimental efforts. (auth)

46125 THEORY OF COLLECTIVE EXCITATIONS IN SPHERICAL ODD-MASS NUCLEI. I. BASIC IDEAS AND CONCEPT OF DRESSED THREE-QUASI-PARTICLE MODES. Kuriyama, Atsushi; Marumori, Toshio; Matsuyanagi, Kenichi (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 45: No. 3, 784-809(Mar 1971).

A new systematic theory of describing the collective excitations in spherical odd-mass nuclei is developed. The theory can be regarded as a direct extension of the conventional quasi-particle new Tamm–Dancoff method (i.e. the quasi-particle random phase approximation) for spherical even-mass nuclei into the case of spherical odd-mass nuclei. In order to construct properly the theory within the framework of the quasi-particle new Tamm–Dancoff method, it is shown to be decisive to introduce a new concept that precisely specifies the "dressed" three-quasi-particle modes. The new concept is recognized in connection with the "quasi-spin space," which has been introduced through the quasi-spin formalism for the pairing correlations. It is not the purpose of this paper, to go into a clear-cut formulation of the theory and into detailed quantitative calculations, but rather to put an emphasis on the explanation of basic ideas. (auth)

46126 ELASTICALLY EQUIVALENT POTENTIALS. Monahan, J. E. (Argonne National Lab., Ill.); Shakin, C. M.; Thaler, R. M. Phys. Rev., C; 4: No. 1, 43-51(Jul 1971).

A nondenumerably infinite class of two-body potentials that give T matrix elements that are identical on the energy shell but are different off shell is defined. The existence of this class is shown to be related to a nonuniqueness in the off-shell continuation of the Schroedinger equation. A relation for the difference between off-shell elements of T matrices that are equal on shell is given in a form that is convenient for the systematic study of off-shell effects in systems of more than two nucleons. In particular, these relations allow one to investigate subclasses of elastically equivalent interaction potentials that satisfy restrictions such as finite range. The possibility that elastically equivalent interactions have different off-shell symmetry properties is discussed, and some observations concerning the use and interpretation of elastically equivalent potentials in many-body calculations are presented. (auth)

46127 DISTORTED WAVE BORN APPROXIMATION FOR NUCLEAR REACTIONS. Tamura, T.; Coker, W. R.; Rybicki, F. (Univ. of Texas, Austin). Comput. Phys. Commun.; 2: No. 2, 94-5(Feb-Mar 1971).

The FORTRAN IV program DWBA-VENUS assembles the quantities needed to compute the transition amplitude for a given direct nuclear reaction in the distorted-wave Born approximation. The principal parts of the transition amplitude, other than angular momentum and kinematic factors, involve the radial wave functions of entrance and exit channels, obtained by solving the radial Schroedinger equation numerically with appropriate optical potentials including spin–orbit coupling, and a form factor, either a single-particle bound-state radial wave function or a derivative of an optical potential. The bound-state wave function is obtained by solving the radial Schroedinger equation for a state of given binding energy in a real Woods–Saxon potential with spin–orbit coupling. The zero-range approximation is used, so that the cross sections are realistic only for inelastic scattering and for transfer reactions with light projectiles. The program, which is overlaid, requires 44,208 60-bit words of storage. For a typical l = 2 (d,p) reaction with spin–orbit coupling, running time is 12 seconds on a CDC 6600 computer. (R.W.R.)

46128 CORRECTIONS TO THE GAUSSIAN OVERLAP APPROXIMATION: A NEW BOSON EXPANSION. Da Providencia, Joao; Urbano, Jose N.; Ferreira, Lidia S. (Univ., Coimbra, Portugal). Nucl. Phys.; A170: No. 1, 129-40(1971).

The Gaussian overlap approximation is applied to Lipkin's solvable model, both for a weak and for a strong interaction, in order to obtain insight on the conditions for the validity of that approximation. By carrying the expansions in the generator coordinate to higher orders, corrections to the harmonic approximation are obtained and applied, also with good results, to Lipkin's model. (auth)

46129 NEUTRON DISTRIBUTIONS FROM A HYDRODYNAMICAL MODEL. Friedman, E. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; A170: No. 1, 214-22(1971).

A hydrodynamical model is used to derive neutron and neutron-excess distributions in nuclei from experimentally determined proton distributions. The results are found to be in good agreement with pion and α-particle scattering data as well as with Coulomb displacement energies. (auth)

46130 SOME RESULTS ON THE BOUNDARY CONDITION MODEL t-MATRIX. Bahethi, O. P.; Fuda, M. G. (State Univ. of New York, Buffalo). Nucl. Phys.; A170: No. 1, 177-86(1971).

It is shown that the pure boundary condition model (BCM) t-matrix obtained from the Hoenig–Lomon pseudopotential does not satisfy the analyticity requirements suggested by Brayshaw, since the t-matrix possesses unphysical poles. A closed form expression is derived for the t-matrix which arises when the external potential in the BCM is taken to be a square well. A separable expansion for the t-matrix is also derived and compared numerically with the closed form result. The rate of convergence is found to be fast enough to be of practical value in calculations on the three-nucleon system. (auth)

46131 USE OF SU(3) IN THE ELIMINATION OF SPURIOUS CENTER OF MASS STATES. Hecht, K. T. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A170: No. 1, 34-54(1971).

SU(3) recoupling techniques are used to give explicit constructions of the spurious states in the SU(3) scheme of the harmonic oscillator shell model. A compact formula is derived for all spurious states of excitation $1\hbar\omega$ in 1p shell nuclei. Spurious states of excitation $1\hbar\omega$ in heavier nuclei can be written down from a general formula whenever the needed fractional parentage coefficients are known. Calculation of spurious states of excitation $2\hbar\omega$ is illustrated with the simple example, ^{16}O. It is shown how the purely non-spurious parts can be projected out of specific core excited states such as those of the weak coupling model for hole and particle states of high SU(3) symmetry. Most of the SU(3) recoupling coefficients needed for the construction of spurious states can be simply related to ordinary SU(2) Racah coefficients. (auth)

46132 QUASI-ELASTIC ELECTRON SCATTERING AND NUCLEAR SHELL STRUCTURE. Viollier, Raoul D.; Alder, Kurt (Univ., Basel). Helv. Phys. Acta; 44: No. 1, 77-94 (15 Feb 1971).

Quasi-elastic electron scattering, knocking out a proton from the target nucleus, is treated in a distorted-wave Born approximation. The coincidence cross section for the N(e,e'p)N' reaction is calculated in the impulse approximation. Since the energy of the emitted proton depends upon the shell and its binding energy, the nuclear shell structure can be studied directly if the angular correlation of the emerging particles is measured. The angular distribution of the outgoing proton is calculated and compared with plane-wave Born-approximation values for ^{40}Ca, ^{32}S, and ^{28}Si. (auth)

46133 CORRECTION FOR ATOMIC EXCITATION ENERGY IN MEASUREMENTS OF ENERGIES OF e^- CAPTURE DECAY. Rubinson, William (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.: A169: No. 3, 629-40(1971).

The theoretical basis for the measurement of the energy of an e^- capture decay by way of the bremsstrahlung endpoint is outlined. It is pointed out that an experimental bremsstrahlung spectrum is a superposition of many spectra, one for each of the possible states of atomic excitation in which the daughter atom can be produced. Consequently it appears that the proper correction from the measured endpoint to the total decay energy should be the mean excitation energy of the daughter atom, rather than simply the binding energy corresponding to the hole left in the daughter by the capture act. The mean excitation energy of the daughter is worked out in detail and compared with the binding energy. The results show that the two are equally adequate as corrections from the endpoint to the total decay energy, even if measurements of the bremsstrahlung spectrum could be made with ideal accuracy. As a by-product of this work various experimental and theoretical values of atomic total binding energies are fitted by non-linear least squares to the form cZ^k suggested by the Thomas–Fermi model. (auth)

46134 APPLICATION OF DISTRIBUTION-FREE STATISTICS TO THE STRUCTURAL ANALYSIS OF SLOW NEUTRON CROSS SECTION AND RESONANCE PARAMETER DATA. James, G. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys.; A170: No. 2, 309-20(1971).

The discovery of narrow intermediate structure and its explanation in terms of shape isomerism has encouraged the search for structure in the energy dependence of low-energy neutron cross-section and resonance parameter data. It is shown how the Wald and Wolfowitz distribution-free statistic can be applied to test for the energy-dependent structure of resonance parameter data in the presence of the well-known fluctuations which these parameters undergo from resonance to resonance. The statistic can also be used on a sequence of serial correlation coefficients and thereby test the assumed energy dependence of cross-section data. Illustrative examples refer to the neutron widths of ^{232}Th, the fission and neutron widths of ^{234}U and the serial correlation coefficients derived from the fission cross sections of ^{239}Pu and ^{235}U. (auth)

46135 SHORT RANGE CORRELATIONS IN NUCLEI. Huber, Max G. (Univ., Erlangen-Nuernberg, Ger.). Ann Phys. (Paris); 5: No. 4, 239-54(Jul-Aug 1970).

The independent particle model (IPM) of the nucleus has to be modified since there are experimental facts which cannot be reconciled with the assumption of independently moving nucleons. Some of these modifications are discussed; special attention was attributed to the so-called short range correlations. The Jastrow method of treating the effects of that part of the short range nucleon–nucleon interaction which cannot be included into the IPM wavefunction is described and analyzed in detail. A number of experiments which presumably contain information about these short range correlations were analyzed and reviewed. The results are discussed in the framework of a consistent description of the nucleus. (auth) (France)

46136 RELIABILITY OF SHELL MODEL CALCULATIONS USING THE DISPERSION RELATION APPROACH. Hodgson, R. J. W. (Univ. of Ottawa). Can. J. Phys.; 49: No. 11, 1401-10(1 Jun 1971).

Two techniques for deriving the Born approximation from the two-nucleon phase shift data in states having $l \leq 4$ are employed to study the influence of the high energy form of the phase shifts in deducing two-body matrix elements and shell model spectra. A comparison is made with results obtained by other approaches. (auth) (Canada)

46137 NUCLEAR MATTER PROPERTIES FOR THE REID, BRESSEL–KERMAN–ROUBEN, AND HAMADA–JOHNSTON POTENTIALS. Banerjee, P. K. (McMaster Univ., Hamilton, Ont.); Sprung, D. W. L. Can. J. Phys.; 49: 1899-1918(15 Jul 1971).

Nuclear matter calculations were carried out for the Reid, Hamada–Johnston, and Bressel–Kerman–Rouben potentials. The convergence of the reference spectrum series for the G matrix is investigated, as is the approximation of choosing an average center of mass momentum. Higher-order cluster contributions are estimated from the scaling formulas of Day. The Reid potential predicts saturation at $k_F = 1.49$ fm^{-1}, with a binding energy -13.7 ± 1.5 MeV per particle. (auth) (Canada)

46138 MODEL OF NONLOCAL POTENTIAL AND ALPHA DECAY OF DEFORMED EVEN NUCLEI. Chaudhury, M. L. (Indian School of Mines, Dhanbad). J. Phys., A (London); 4: No. 3, 328-45(May 1971).

The problem of α decay of deformed even nuclei is treated by assuming the barrier to be the usual anisotropic electrostatic potential superimposed by a nonlocal α–nuclear potential. The electrostatic potential is, for simplicity, described by the usual quadrupole deformation parameter $\beta_{2,0}$, while the nonlocal part is taken for the same reason to be spheroidal, described by a deformation parameter ϵ_l. The latter potential being momentum-dependent, ϵ_l may naturally take different values for different α angular momenta l. Furthermore, the barrier penetration effects are taken to be the main factors governing hindrances to the excited state transitions. With these assumptions a formula for hindrance factor, $(H.F.)_l$, is derived. Then from straightforward calculations, and with a single value of ϵ_l for different nuclei ($\beta_{2,0}$ being known from experiments), the values of $(H.F.)_l$ are found to be within 50% of the empirical values, whereas the values from the shell-model theory or from a purely Coulomb or static barrier hypothesis show large discrepancies. Similarly, for $l \leq 6$, overall agreement for an average ϵ_l is better than obtained previously. On the other hand, it is remarkable that for the best-fit values of an ϵ_l varying slightly with nuclear mass A and charge Z (which appear not unreasonable by analogy with the similar variations of $\beta_{2,0}$) one obtains exact agreement with (within 10%) all the empirical $(H.F.)_l$ values discussed. (auth) (UK)

XUM

46139 COMPOUND NUCLEUS CROSS-SECTION CALCULATIONS FOR α-PARTICLES IN PARABOLIC APPROXIMATION. Oblozinsky, P.; Ribansky, I. (Inst. of Physics, Bratislava). Fyz. Cas.; 20: No. 2, 119-22(1970).

A method of compound nucleus cross-section calculations based on calculations of $T_l(E_a)$ coefficients is briefly described. A program for $T_l(E_a)$ calculations was written in Algol 4. The calculations result in values of $\sigma_{CN}^{(J)}(E_a)$ which are needed for statistical calculations of nuclear reactions. Some of the results are given in graphs. (NSA of Czech)

46140 TWO PARTICLE–ONE HOLE CONTRIBUTIONS TO MAGNETIC MOMENTS AND M1 TRANSITIONS. Castel, B.; Johnstone, I. P. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 49: 1641-3(15 Jun 1971).

The success of the core-particle nuclear model in predicting energy levels and E2 transitions is partially offset by strong disagreements on M1 rates. A perturbation method suggested recently by Green is used to determine the contributions to magnetic moments and M1 transitions from 2p–1h components. A marked improvement on previous M1 results is obtained with realistic values of spectroscopic parameters. (auth) (Canada)

46141 EFFECTIVE SCHROEDINGER EQUATIONS FOR THE ELASTIC INTERACTION OF HEAVY IONS. Pruess, K. (Univ., Frankfurt am Main). Nucl. Phys.; A170: No. 2, 336-52(1971).

Starting from the many-body Schroedinger equation and using completely antisymmetric state vectors, an effective Hamiltonian formalism is developed which is appropriate for a description of elastic scattering of heavy ions. The additional potential terms arising from the elimination of all non-elastic channels are nonlocal and non-hermitean. They can be written in terms of transition amplitudes and state densities, so that an approximate evaluation seems possible within the two-center shell model. Special attention is paid to the imaginary part of the potential. Some qualitative features of the imaginary potential are discussed, taking integrals of motion into account. Finally, the possible extension of the treatment to reaction channels is sketched. (auth)

46142 ROLE OF INTERMEDIATE NUCLEAR STATES IN PARTICLE TRANSFER REACTIONS BETWEEN COMPLEX NUCLEI. Nishida, Yoshihiko (Saga Univ., Japan). Nucl. Phys.; A170: No. 2, 401-16(1971).

An attempt is made to estimate the role of intermediate nuclear states in particle transfer reactions between complex nuclei at an energy region above the Coulomb barrier. The grazing contact transfer process where the angular distributions of reaction products are markedly peaked at a forward direction is chosen for this purpose, and the semiclassical transfer model proposed by Breit for a tunnelling problem below the Coulomb barrier is employed to describe the behavior of the particle in the process. While the model is certainly unrealistic in that it assumes a one-dimensional delta-function potential for the interaction between the particle and either core nucleus, this has the great advantage that it admits an exact solution and therefore the role of intermediate nuclear states can be found by comparing the result of the first-order perturbation calculation with the exact one. The exact transfer amplitude is calculated and is shown to be represented by an infinite single series. The perturbation approximation is formulated and its limitation of application is discussed. An effective interaction is introduced between the particle and the capturing nucleus to reproduce the exact transfer probability within the framework of the first-order approximation, and its ratio to the true interaction, whose deviation from unity indicates a measure of the contribution of intermediate nuclear states, is calculated. It is shown that this ratio changes remarkably with a parameter depending on the binding energies of the particle in its initial and final states and the incident energy, its numerical value ranging between 0.82 and 0.075. It is pointed out that such an important role of intermediate nuclear states leads to the suggestion that the application of the formal DWBA, as the case may be, should be very careful. (auth)

46143 COLLECTIVE INERTIAE, LEVEL CROSSINGS, AND PAIRING. Griffin, James J. (Univ. of Maryland, College Park). Nucl. Phys.; A170: No. 2, 395-400(1971).

The BCS–Belyaev model of nuclear superfluidity is utilized to estimate the reduction due to nuclear pairing of the contribution to the collective vibrational inertia arising from crossings of independent-particle levels. It is found that the dimensionless factor which pairing effects introduce is proportional to $(G/\Delta)^2(\approx 10^{-2}$ for heavy nuclei), where G is the pairing matrix element and Δ is the pairing gap parameter. Even with this large diminution, however, when crossings occur with a typical frequency their contribution still dominates the overall magnitude of the inertial parameters, and guarantees that in general they exceed the irrotational values by at least an order of magnitude. (auth)

46144 NUCLEAR PHOTO-EMISSION FOLLOWING RADIATIVE PION ABSORPTION. Guy, R. (Wisconsin State Univ., Oshkosh) ; Eisenberg, J. M. Can. J. Phys.; 49: 1879-84(15 Jul 1971).

The process in which the radiative absorption of a bound pion is followed by photon deexcitation of the residual nucleus is considered. The particle–hole formalism is used for the evaluation of nuclear matrix elements and it is assumed that odd-parity spin–isospin nuclear states are excited by the radiative pion absorption mechanism. Results are presented for ^{12}C and ^{16}O, including energy distributions for the outgoing photons for the case in which the pion is absorbed from the 2P atomic orbital. (auth) (Canada)

REACTOR TECHNOLOGY

Commercial Power Reactors

46145 (CONF-710511-2) NUCLEAR POWER IN AUSTRALIA. Baxter, J. P. (Australian Atomic Energy Commission). 1971. 20p. Dep. NTIS (U. S. Sales Only).

From forty-third congress of the Australian and New Zealand association for the advancement of science; Brisbane, Australia (24 May 1971).

The role of nuclear power in Australia is considered from two aspects: domestic power production; and a nuclear fuel export industry. The pattern of growth for power production is expected to incorporate converter reactors initially in New South Wales, Victoria, South Australia and possibly parts of Western Australia during 1985 to 1990. Desalination plants and special purpose reactors in other areas may well be included in the latter half of this period. The AAEC has estimated 4000 MW of nuclear power in 1985 (9.3% of total installed capacity from all sources), 11,500 MW in 1990 (18.9%), 22,500 MW in 1995 (27.2%) and 36,000 MW in 2000 (32.8%). Considerations taken into account in the choice of a nuclear power reactor system best suited to local conditions are outlined, with reference to tenders for the proposed Jervis Bay power station. The emergence of Australia as a major source of uranium prompts discussion on the establishment of a uranium industry in Australia. Comparison is made between the gaseous diffusion and centrifuge processes, and their potential for Australia is discussed. (Australia)

46146 (DOCKET-1155-130) LA CROSSE BOILING WATER REACTOR. Containment Vessel Class-A Integrated Leak Rate Test of October 1969. (Dairyland Power Cooperative, La Crosse, Wis.). Jun 1971. 52p. (DPC-851-27). Dep. NTIS.

46147 (DOCKET-1155-131) LA CROSSE BOILING WATER REACTOR. Control Rod Drive Mechanism No. 4, Roller Nut Guide. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jun 1971. 64p. Dep. NTIS.

On March 20, 1969, a failure of the control rod drive No. 4 upper mechanism was reported. Stress studies were performed to investigate the drive mechanism failure. The results and conclusions of the analysis and additional details concerning the failure are presented. (H.D.R.)

46148 (DOCKET-50003-84) INDIAN POINT STATION, UNIT NO. 1. Sensitized Stainless Steel. (Consolidated Edison Co. of New York, Inc., New York). 30 Jul 1971. 23p. Dep. NTIS.

Presented are detailed answers to questions related to the use of sensitized stainless steel in the Unit 1 cooling system boundary. The satisfactory performance of these areas is indicated and an inspection program to verify their continued adequate performance is described. (H.D.R.)

46149 (DOCKET-50237-188) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Unplanned Liquid Release. (Commonwealth Edison Co., Chicago, Ill.). 8 Aug 1971. 1p. (DOCKET-50249-84). Dep. NTIS.

46150 (DOCKET-50249-85) DRESDEN NUCLEAR POWER STATION, UNIT 3. Technical Specifications, Mechanical Vacuum Pump Suction Valve not Fully Closed. (Commonwealth Edison Co., Chicago, Ill.). 3 Aug 1971. 1p. Dep. NTIS.

46151 (DOCKET-50249-86) DRESDEN NUCLEAR POWER STATION, UNIT 3. Technical Specifications, Upper Isolation Valve for a Scram Discharge Volume Level Switch Found in Closed Position. (Commonwealth Edison Co., Chicago, Ill.). 3 Aug 1971. 2p. Dep. NTIS.

46152 (DOCKET-50249-87) DRESDEN NUCLEAR POWER STATION, UNIT 3. Technical Specifications, Apparent Failure of Scram Relay. (Commonwealth Edison Co., Chicago, Ill.). 5 Aug 1971. 1p. Dep. NTIS.

46153 (IAEA-119) INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL. Report of a Panel, Vienna, 17-21 November 1969. (International Atomic Energy Agency, Vienna (Austria)). 1970. v.p. (CONF-691116). INIS.

Abstracts of papers from the meeting were previously presented in NSA. (D.H.M.)

46154 (KURRI-TR-75, pp 53-9) ON-LINE PROCESS CONTROL COMPUTER FOR TSURUGA REACTOR. Nagayama, Satoshi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The trend of nuclear power plants toward high power and high efficiency will require more sophisticated operational control, while fail-safe and reliability will need closed-loop on-line process control. The on-line process control computer for Tsuruga Reactor is the first closed-loop type computer applied to operational power plants in Japan. Softwares for the process control computer include: (1) reactor core performance; (2) RWM; (3) transient control and fault-location; (4) plant performance; (5) operational aids; (6) shut-down of the computer and processing function afterwards; and (7) "static" and "dynamic" priority allocation. Hardware of the system consists of a central processing unit GE/PAC 4020 with 32 Kw core memory, two magnetic drums, a paper tape reader, a paper tape punch, five type writers, and an operator console. The system provides 184 points of digital input, 230 points of analog inputs and 11 groups of BCD output (16 contacts/group). Installation of the system began in Feb. 1969, and following two months were spent for hardware check-up. About ten months were required for program debugging, and another several months will be needed before completion of the entire system. (Japan)

46155 (TRG-Report-1943) FUEL PERFORMANCE IN THE PROTOTYPE SGHWR POWER STATION. Pickman, D. O. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). 14 Oct 1969. 19p. Dep. NTIS (U. S. Sales Only).

During the first 18 months of full power operation leaks have developed in some fuel pins, the majority of which have now been identified as a result of local overheating of the cladding. This effect has been studied in detail. It is not conventional dry-out, but is associated with the deposition of a heavy copper-rich crud layer on the heated surfaces. The mechanism of overheating is believed to involve the cracking of the crud layer and the formation of a stagnant steam gap between crud and cladding, but a possible alternative is that the in-filling of the porosity in the initial ferrous crud deposit, by copper, is of itself sufficient to produce the overheating. Three fuel elements have been discharged in which defected fuel pins did not show evidence of overheating. Extremely small leaks have been found (10^{-5} to 10^{-6} lusecs) in the cladding of these pins which might be due to minor adventitious internal contamination, possibly a combination of H_2O and F. These pins all defected during the first 5 months of operation, supporting the view that they were fortuitous rather than systematic defects. Highest rated fuel elements have reached a burnup of 5400 MWd/tU channel average (9000 MWd/tU peak) and post-irradiation examination has shown that the design concept is satisfactory. Of particular interest is the performance of the spacer design using brazed wear pads and clearance fit grid, which has been completely effective in preventing fretting. The cladding corrosion, dimensional changes and fission gas release are all within the predicted limits and should not present any problems at the full design burnup of 21000 MWd/tU. The mechanical properties of irradiated cladding have not been fully assessed, but simple tests show it to have substantial ductility at room temperature, including the heat affected regions surrounding the brazed wear pads. It has been established that the heavy crud deposition, which has constituted the only major problem with SGHWR, originated during an early period of defective functioning of the ion exchange/filter units in the feed lines. A simple modification, together with the removal of a copper alloy deaerator condenser situated downstream of the clean-up plant, has given a large improvement in feed-water purity. The resultant crud deposition rate, assessed over the first 6 months of 1969, has been dramatically reduced. Extrapolation suggests that crud deposits at end of life will be less than those which have previously caused the overheating problem. 5 references. (auth)

46156 (ZJE-100) TEMPERATURE FIELD IN A FUEL ELEMENT WITH THE ARBITRARY DISTRIBUTION OF HEAT SOURCES. Krettova, A. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1971. 20p. Dep. NTIS (U. S. Sales Only).

The method of determining the distribution of rods in an A-1 power station type fuel element with the aim of flattening the gradient of fuel surface temperature in radial direction is described. The method of fuel element temperature field calculation with other than cosine axial distribution of the neutron flux is discussed. The effect of this distribution on the basic thermal parameters of the element and the thermal efficiency is investigated. The results are compared with a case of cosine distribution of heat sources along the fuel element height used in current calculations of heat removal from the reactor core. (auth)

XUM

46157 RULES FOR INSERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. ASME Boiler and Pressure Vessel Code, Section XI 1971. New York; American Society of Mechanical Engineers (1971). 22p. Available from American Society of Mechanical Engineers, New York.

Rules for inservice inspection of cooling system components and supports in light water cooled power reactors are presented. Included in the rules are classification of the areas subject to inspection, responsibilities, provisions for accessibility, definitions of examination methods, examination techniques and procedures, personnel qualifications, frequency of inspection, records, mapping, evaluation of inspection results, and disposition and repair requirements. (H.D.R.)

46158 WASTE HEAT CAN BE AN ASSET. Bregman, J. I. (Water Pollution Research and Applications, Inc., Washington, D. C.). Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 43-5(1971).

The thesis that it is more economical, as well as socially desirable, to utilize as an asset the waste heat from nuclear power plants is presented. Some of the potential beneficial applications of this waste heat are discussed. (H.D.R.)

46159 IMPROVEMENTS IN OR RELATING TO COOLING GAS CIRCULATORS FOR NUCLEAR REACTOR POWER STATIONS. Cairns, Walter John; MacDonald, Ian Norman (to James Howden and Co. Ltd.). British Patent 1,237,691. 30 Jun 1971. Filed 12 Oct 1967.

In conventional circulators, to enable the gas flow to be varied, angularly adjustable vanes are provided in the blower inlet passage, and the vane adjusting means includes gearing arranged close to the inlet passage. This arrangement presents difficulties in operation as the gearing is required to operate at high temperatures and without lubrication, since no lubricant is permitted in the vicinity of the vanes. The object of the arrangement described is to obviate or mitigate these difficulties. In this arrangement the impeller casing is located with the gas passage adjacent to the inner end of the circulator housing, and angularly adjustable vanes are provided in this passage, the vane adjusting means extending through the inner end of the circulator housing. The gas passage is preferably annular and radially directed, and a peripheral series of vanes is pivatably mounted in the passage. A suitable design of vane adjusting means is described. (UK)

46160 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Chambon, Peter; Hawkins, Ronald James (to Babcock and Wilcox Ltd.). British Patent 1,236,281. 23 Jun 1971. Filed 7 Mar 1968.

Reference is made to tubular heat exchangers required to withstand coolant entry temperatures of the order of 750°C; for such service high quality materials must be used for structural components. The object of the described system is to allow the use of lesser quality materials for the support of tubes in such exchangers. A bank of tubes, through which a first fluid may flow, is housed within an enclosure through which a second heating fluid may flow in heat exchange relationship. The bank of tubes is supported from below by a base, and the flow path for the second fluid is such that the fluid first flows over the bank of tubes and then over the base. The base is supported by a cooled suspension means. Various constructional and flow path alternatives are described. The enclosure may be an integral part of a concrete reactor pressure vessel. (UK)

46161 IMPROVEMENTS IN POWER SUPPLY ARRANGEMENTS FOR COOLANT CIRCULATORS OF NUCLEAR REACTOR. Ivanoff, Victor (to Hayward Tyler and Co. Ltd.). British Patent 1,236,538. 23 Jun 1971. Filed 26 May 1970.

Reference is made, in particular, to coolant systems of liquid-cooled reactors. It has been proposed to prevent a sudden cessation of coolant flow, such as due to electrical power failure, by using flywheel stored energy to extend the run-down time of the coolant circulator pumps when the power supply is withdrawn; certain difficulties arise, however, in this scheme, which the arrangement described seeks to avoid or alleviate. This arrangement comprises a glandless circulator driven by an AC motor having an auxiliary motor connected in parallel, the rotor of which is coupled to a flywheel from which, in the event of power failure, energy is supplied to extend the coast-down time of the circulators. Various designs of auxiliary motors may be employed, including battery operated. Protective devices may be included to prevent a defect in the auxiliary motor from producing a supply failure to the pump drive motor. (UK)

46162 VESSELS. Collis-Smith, John Anthony; Perrett, Robert James (to English Electric Co. Ltd.). British Patent 1,236,465. 23 Jun 1971. Filed 20 Jun 1968.

A liquid metal cooled reactor construction is described that includes an inner circular vessel carried in an outer vessel, with a duct communicating between the two vessels. The duct extends radially outwards from the inner vessel and passes through and is fixed in the outer extremity of a radially outwardly projecting hollow extension of the wall of the outer vessel. The length of the duct is substantially greater than the average separation of the two vessels, allowing readier relative movement of the two vessels due to thermal expansion when operating at different temperatures. The reactor core may be sited at the bottom of the inner vessel, and coolant passages provided connecting the two vessels. The first duct enables flow of hot metal coolant from the inner vessel, and a second duct may be provided to enable flow of cooled metal coolant to the space between the inner and outer vessels. This system is especially applicable where the space between the inner and outer vessels, and the inner vessel, contain fluid at high pressure and such devices as sliding seals or glands around the duct, where it passes through the outer vessel, must be avoided. More than one of each duct may be provided, and these may be arranged relative to each other, and to the tanks, so as to cause distortion of the tanks to occur in the most acceptable way, that is, in such a way as to induce an acceptable, and preferably symmetrical, stress distribution in the tanks. (UK)

46163 NUCLEAR REACTOR INSTALLATIONS. Ebeling, Douglas Roy (to United Kingdom Atomic Energy Authority). British Patent 1,236,578. 23 Jun 1971. Filed 29 Nov 1967.

Reference is made to the cooling system arrangements of pressurized water reactors. In conventional systems pressure suppression means have been adopted to control the effect of a breach in the coolant circuit; the system here described, however, is directed toward preventing the occurrence of such a breach. The reactor has a boundary means defining a coolant conducting circuit enclosed within a pressure vessel, the boundary means including tubes that house nuclear fuel cooled by pressurized water and that pass through a closed calandria tank containing liquid moderator. The reactor and boundary means are enveloped by a static and substantially anhydrous gaseous atmosphere in the pressure vessel, at substantially the same pressure as the coolant water. The system provides that stress due to pressure differential across the boundary walls of the coolant circuit is low, so that a large breach is inconceivable. Bursting pressure is constrained by the pressure vessel, which may be a prestressed concrete vessel of substantial proportions. Neutron absorbing material within the reactor core may be considerably reduced, since the tube walls, which may be Zr alloy, can be made thinner. By pressurizing the calandria tank the pressure differential across the walls of the calandria tubes may be made low, so that the wall thickness of the calandria tubes may also be reduced. (UK)

46164 RADIOACTIVITY OF CORROSION PRODUCTS IN THE WATER OF AN EXPERIMENTAL LOOP IN THE VVR-S REACTOR. Kopec, Josef; Tomaskova, Lenka. Jad. Energ.; 17: No. 6, 200-4(1971). (In Czech).

The buildup of radionuclides in the heavy water circuit of the A-1 electric power station was investigated. The activity of corrosion products in a D_2O loop was studied under typical operating conditions of the KS-150 reactor. The technique of measuring radioisotope activity produced in a loop is described, and the results are compared with theoretical considerations concerning the appearance of radioisotopes in the D_2O. 18 references. (tr-auth)

46165 NUCLEAR REACTORS. Higson, Donald James; Ebeling, Douglas Roy; Gilbert, Charles Philip (to United Kingdom Atomic Energy Authority). British Patent 1,236,210. 23 Jun 1971. Filed 12 Feb 1968.

Reference is made to means for delaying voiding of fuel channels of steam generating nuclear reactors having a positive void coefficient of reactivity if the normal coolant flow is interrupted. In the system described the coolant circuit has non-return arrangements between the fuel channels inlet and the circulating means for preventing flow toward the latter, and a branch pipe extending from a connection between the channels inlet and the non-return means to below the surface of a mass of liquid coolant in a pressurized vessel in which an atmosphere pressure of inert gas above the coolant is substantially balanced by the coolant circuit pressure. The pressurized vessel is termed a "hydraulic accumulator". In the event of an interruption of coolant flow the pressure within this accumulator will urge coolant into the fuel channels, thereby preventing rapid divergence of the reactor and delaying voiding for a period long enough to allow operation of emergency shut-down devices and to bring emergency cooling systems into operation. Preferably the coolant circuit at the outlet from the fuel channels has constrictions, which may be venturing, to restrict the rate of flow from the channels in the event of a breach of the coolant circuit between the channels outlet and the circulating means. The constrictions limit the rate of depressurization of the channels and therefore the transient fall in coolant density. In some circumstances the constrictions may cause a transient increase in coolant density, there-

by tending to depress reactivity. By restricting the rate of flow from the coolant tubes the constrictions conserve the supply of coolant from the hydraulic accumulator. Alternative nuclear reactor constructions embodying this system are described. (UK)

Operation and Economics

46166 (DOCKET-1155-127) LA CROSSE BOILING WATER REACTOR. Physics and Fuel Management Codes. (Dairyland Power Cooperative, La Crosse, Wis.). 21 Jul 1971. 55p. Dep. NTIS.

46167 (DOCKET-1155-128) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Shutdown Caused by a Malfunction of Power Range Channel No. 5 in the Automatic Gain Control Mode. (Dairyland Power Cooperative, La Crosse, Wis.). 23 Jul 1971. 3p. (DPC-71-14). Dep. NTIS.

46168 (DOCKET-1155-129) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Shutdown. (Dairyland Power Cooperative, La Crosse, Wis.). 23 Jul 1971. 2p. (DPC-71-15). Dep. NTIS.

An unplanned shutdown resulting from incorrect downscaling of a nuclear instrumentation wide range channel during test procedures is described. The shutdown was a result of operator error. (D.C.C.)

46169 (DOCKET-50003-81) INDIAN POINT STATION, UNIT NO. 1. Malfunction of Control Rod No. 21. (Consolidated Edison Co. of New York, Inc., New York). 23 Jul 1971. 3p. Dep. NTIS.

46170 (DOCKET-50003-82) INDIAN POINT STATION, UNIT NO. 1. Incoming Electrical Power Interrupted Due to Automatic Shutdown of Substation. (Consolidated Edison Co. of New York, Inc., New York). 26 Jul 1971. 2p. Dep. NTIS.

46171 (DOCKET-50003-83) INDIAN POINT STATION, UNIT NO. 1. Chlorine Concentration in Excess of Technical Specifications Maximum. (Consolidated Edison Co. of New York, Inc., New York). 26 Jul 1971. 2p. Dep. NTIS.

46172 (DOCKET-50016-123) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Supplementary Report on the March 2, 1971 Sodium-Fluorolube Incident. (Power Reactor Development Co., Detroit, Mich.). Jul 1971. 66p. Dep. NTIS.

At about 1745 hours on March 2, 1971, a sodium-fluorolube chemical reaction occurred in No. 2 primary sodium pump. The results of post-incident investigations and reactor operations are described. Information presented includes: the effect of adding the reaction products to the primary sodium on the expected corrosion behavior of the components; two tests conducted in an off-site sodium laboratory to characterize the chemical reaction; the results of a review conducted by a consultant to forecast the behavior of the reaction products; an evaluation of the primary sodium cleanup program; descriptions of the revisions to the reactor operating procedures and an evaluation of their effectiveness; and the results of reviewing the design of the shaft seal lubrication systems for the primary sodium pump overflow pumps and secondary sodium pumps. 38 references. (auth)

46173 (DOCKET-50029-154) YANKEE NUCLEAR POWER STATION. Operation Report No. 126, June 1971. (Yankee Atomic Electric Co., Westboro, Mass.). 28 Jul 1971. 5p. Dep. NTIS.

46174 (DOCKET-50155-86) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 81, April-June 1971. (Consumers Power Co., Jackson, Mich.). 19 Jul 1971. 29p. Dep. NTIS.

46175 (DOCKET-50237-187) DRESDEN NUCLEAR POWER STATION, UNIT 2. HPCI Turbine Failure to Reset. (Commonwealth Edison Co., Chicago, Ill.). 6 Aug 1971. 1p. Dep. NTIS.

46176 (DOCKET-50255-50) PALISADES PLANT. Incident in the Instrument Air System. (Consumers Power Co., Jackson, Mich.). 30 Jul 1971. 2p. Dep. NTIS.

46177 (DOCKET-50263-76) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Reactor Isolation From 90 Percent Power and Subsequent Events. (Northern States Power Co., Minneapolis, Minn.). 23 Jul 1971. 8p. Dep. NTIS.

The reactor isolation was initiated by noise spiking on the main steam line flow sensors while completing scheduled surveillance testing. Corrective actions and safety procedures following the isolation incident are described. (D.C.C.)

46178 (DUN-7541) ALTERNATE PROCEDURES FOR THE EXTENDED LAYUP OF N REACTOR. Bainard, W. D.; Kratzer, W. K.; Larrick, A. P. (Douglas United Nuclear, Inc., Richland, Wash.). [nd]. Contract AT(45-1)-1857. 10p. Dep. NTIS.

46179 (EUR-4616) LINGEN NUCLEAR POWER PLANT. Annual Report, 1969. (Kernkraftwerk Lingen G.m.b.H. (West Germany)). 2 Dec 1970. 48p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 5,10.

On 1 October 1968, operation of the nuclear power plant erected by AEG-Telefunken was taken over by KWL. From then on the plant operated continuously, i.e., without refuelling. The summary report on that operating period reviews the initial "teething troubles" and shows how they were overcome. (auth)

46180 (HEDL-SA-218) TECHNOLOGICAL FORECASTING AND MORPHOLOGICAL ANALYSIS. Fields, S. R. (Hanford Engineering Development Lab., Richland, Wash.). [1971]. 24p. (CONF-710707-1). Dep. NTIS.

From American Society of Civil Engineers meeting; Seattle, Wash. (26 Jul 1971).

Morphological analysis is a method for identifying and evaluating all possible combinations of basic characteristics (these combinations represent possible alternatives) of a device or idea. It is a problem solving technique which is useful in technological forecasting and advanced planning as a tool for expanding the state-of-the-art into the unexplored space of new opportunities. It is particularly useful as a forecasting tool when a future-oriented consensus of expert opinion is used for the construction and evaluation of the morphological space. Morphological analysis is illustrated by presenting the current results of a study to identify and evaluate possible beneficial uses of waste heat from thermal power plants. 6 references. (auth)

46181 TRIAL OPERATION OF NO. 1 PLANT IN THE MIHAMA NUCLEAR POWER STATION OF KANSAI ELECTRIC POWER COMPANY. Hamaguchi, Shunichi (Kansai Electric Power Co. Inc., Osaka). Doryoku; 20: No. 115, 70-80(Nov 1970). (In Japanese).

The No. 1 plant in the Mihama nuclear power station is the first PWR plant in Japan. It faces the Japan Sea in Fukui Prefecture. Some features are electric output of 340 MW, two-loop cooling, 40 tons of slightly enriched UO_2 for initial fuel charge, cylindrical containment vessel, and reactor control with control rods and chemical. It attained criticality in July 1970. Startup is described in the following: pre-operation tests at ordinary and elevated temperatures, leak test of the containment vessel, fuel loading, critical and zero-power tests, and power-up tests. (Japan)

46182 ENERGY COMBINATION BETWEEN NUCLEAR AND CONVENTIONAL POWER PLANTS. Frewer, H. (Kraftwerk Union AG, Erlangen, Ger.). Atomwirt., Atomtech.; 16: No. 7, 345-53(Jul 1971). (In German).

With the exception of soft coal, the cost inreases of fossil fuels accelerate a change in the structure of energy production in which nuclear energy becomes more favored. On the other hand, the increase in the construction cost of nuclear power plants favors a combination with fossil plants, especially with gas turbines to meet peak demands. Future challenges for both engineers and economists consist in determining the optimal combination between nuclear and conventional power plants with minimal burden to the environment. The amount of available cooling water from rivers also significantly determines future site selection for energy producers. (31 references) (tr-auth)

46183 OPERATION RESULTS OF THE GERMAN NUCLEAR POWER PLANTS DURING 1970. Atomwirt., Atomtech.; 16: No. 7, 373-7(Jul 1971). (In German).

During 1970, no additional nuclear power plants became operational in addition to the existing six. Operational results of the existing plants, however, showed a significant enhancement of their average availability. This favorable development was doubtlessly caused by overcoming initial difficulties encountered in new techniques as well as in single plants. Operation of the six plants is detailed and depicted in diagrams. (H.B.G.)

46184 OPERATIONAL RESULTS OF THE NUCLEAR POWER PLANTS IN THE EUROPEAN COMMUNITY DURING 1970 WITH SUPPLEMENTARY DATA FOR 1963 TO 1970. Atomwirt., Atomtech.; 16: No. 7, 377-80(Jul 1971). (In German).

For the year 1970, operational results of nuclear power plants and electricity production are summarized for the European community. Statistics also are given for the twelve large nuclear power plants in Germany, France, and Italy throughout the period from 1963 to 1970. Findings are compiled in tables. (H.B.G.)

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Safety and Siting

46185 (CONF-700956-1) PROBLEMS OF SITES FOR NUCLEAR POWER STATIONS. Ailleret, Pierre (International Union of Producers and Distributors of Electrical Energy, Paris (France). Nuclear Energy Study Committee). [nd]. 9p. Dep. NTIS (U. S. Sales Only).

From fifteenth international congress of the international union of producers and distributors of electrical energy; Cannes, France (13 Sep 1970).

Size limitations of the sites for the various types of thermal power-stations (conventional, light water reactors, breeder reactors) resulting from river water heating are analyzed. The problem is not the same if there is only a single unit, or several units in operation on the same river. The possible consequences of the limitations in the utilisation of the rivers as a source of cooling water are discussed. The precise definition of site cost and factors that can limit the concentration of units on a minimum number of sites are described. The evolution in public opinion regarding the fear of repercussions on the population of possible accidents in nuclear power stations is mentioned. The consequences of site difficulties for power station operators are discussed. (auth)

46186 (DOCKET-1153-18) HALLAM NUCLEAR POWER FACILITY. Order Terminating Operating Authorization. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Jul 1971. 14p. Dep. NTIS.

The safety evaluation by the Division of Reactor Licensing of the retirement plan for Hallam Power Reactor is presented. (D.C.C.)

46187 (DOCKET-50010-90) DRESDEN NUCLEAR POWER STATION, UNIT 1. Off-Gas Line Rupture Discs Blown and Off-Gas Released at Ground Level. (Commonwealth Edison Co., Chicago, Ill.). 13 Aug 1971. 2p. Dep. NTIS.

46188 (DOCKET-50155-87) BIG ROCK POINT NUCLEAR PLANT. Proposed Change No. 26 to Technical Specifications of Facility Operating License No. DPR-6. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Jul 1971. 7p. Dep. NTIS.

Revised technical specifications concerning emergency core cooling system modifications are presented. (D.C.C.)

46189 (DOCKET-50206-116) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Proposed Change No. 6 to Technical Specifications of Provisional Operating License No. DPR-13. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 16 Jul 1971. 7p. Dep. NTIS.

Revised technical specifications concerning job titles for nuclear safety committee members are presented. (D.C.C.)

46190 (DOCKET-50206-117) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Proposed Change No. 7 to Technical Specifications of Provisional Operating License No. DPR-13. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 16 Jul 1971. 11p. Dep. NTIS.

Revised technical specifications concerning core burnup limits are presented. (D.C.C.)

46191 (DOCKET-50220-66) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Plans for Partial Refueling to Begin With Outage. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 27 Jul 1971. 15p. Dep. NTIS.

Design parameters for the Type 2 reload fuel assemblies are presented. Refueling procedures are described. (D.C.C.)

46192 (DOCKET-50231-91) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Change No. 4 to Technical Specifications of Provisional Operating License No. DR-15. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Aug 1971. 6p. Dep. NTIS.

The initiation of super-prompt critical transient tests in SEFOR is approved and the required changes in the Technical Specifications are presented. (H.D.R.)

46193 (DOCKET-50254-47) QUAD-CITIES STATION, UNIT 1. Additional Information Concerning Request to Load Fuel and Perform Tests. (Commonwealth Edison Co., Chicago, Ill. Iowa-Illinois Gas and Electric Co., Davenport, Iowa). 26 Jul 1971. 3p. Dep. NTIS.

46194 (DOCKET-50259-23) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 13. (Tennessee Valley Authority, Chattanooga. Office of Power). 29 Jul 1971. 279p. (DOCKET-50260-23; DOCKET-50296-22). Dep. NTIS.

Revised design parameters of the Browns Ferry Power Reactor Units 1, 2, and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

46195 (DOCKET-50259-24) BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2. Environmental Radioactivity Levels. Semiannual Report, July-December 1970. (Tennessee Valley Authority, Chattanooga. Div. of Environmental Research Development). 6 Aug 1971. 32p. (DOCKET-50260-24; DOCKET-50296-23). Dep. NTIS.

46196 (DOCKET-50263-77) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Environmental Monitoring and Ecological Studies 1970 Annual Report. (Northern States Power Co., Minneapolis, Minn.). 21 Jul 1971. 330p. Dep. NTIS.

46197 (DOCKET-50269-34) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 27 (Includes Additional Information and Revisions to Final Safety Analysis Report, Rev. 16). (Duke Power Co., Charlotte, N. C.). 30 Jul 1971. 491p. (DOCKET-50270-32; DOCKET-50287-29). Dep. NTIS.

Revised and additional data on design parameters and operations aspects of Oconee Power Reactor Units 1, 2, and 3 are presented. Technical specifications for Unit 1 are included. (D.C.C.)

46198 (DOCKET-50269-35) OCONEE NUCLEAR STATION, UNIT 1. Items Which Appeared not to be in Compliance with FSAR on Inspection May 30-June 1 and June 8-11, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 19 Jul 1971. 5p. Dep. NTIS.

46199 (DOCKET-50271-60) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Amendment 29. (Vermont Yankee Nuclear Power Corp., Rutland). 6 Aug 1971. 18p. Dep. NTIS.

Revised and additional information on the design and operation of the Vermont Yankee Power Reactor is presented. (H.D.R.)

46200 (DOCKET-50280-44) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 24. (Virginia Electric and Power Co., Richmond). 6 Aug 1971. 42p. (DOCKET-50281-43). Dep. NTIS.

The license application for Units 1 and 2 is amended by the submission of additional information on legal and management aspects. Revised and requested information on the design and operations aspects is included. (H.D.R.)

46201 (DOCKET-50282-36) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Integrated Evaluation of the Dual Containment System. (Pioneer Service and Engineering Co., Chicago, Ill.). 29 Jun 1971. 122p. (DOCKET-50306-36; DOCKET-50305-22; PSE-101). Dep. NTIS.

46202 (DOCKET-50285-47) FORT CALHOUN STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 27 (Includes Final Safety Analysis Report, Suppl. No. 10). (Omaha Public Power District, Nebr.). 30 Jul 1971. 162p. Dep. NTIS.

Revised design parameters of the Fort Calhoun Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46203 (DOCKET-50289-37) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Fuel Handling Building Concrete Wall. (Metropolitan Edison Co., Reading, Pa.). 30 Jul 1971. 4p. Dep. NTIS.

46204 (DOCKET-50293-52) PILGRIM NUCLEAR POWER STATION. Analysis and Comparison with Interim Acceptance Criteria for Performance of ECCS for Light Water Reactors. (Boston Edison Co., Mass.). 22 Jul 1971. 26p. Dep. NTIS.

Requested additional information concerning performance of the emergency core cooling system is presented. (D.C.C.)

46205 (DOCKET-50309-39) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 28 (Includes Additions and Revisions to Final Safety Analysis Report). (Maine Yankee Atomic Power Co., Westboro, Mass.). 22 Jul 1971. 32p. Dep. NTIS.

Revised design parameters of the Maine Yankee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46206 (DOCKET-50321-23) EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2. Supplementary Information to Environmental Statement. (Georgia Power Co., Atlanta). 26 Jul 1971. 4p. (DOCKET-50366-12). Dep. NTIS.

Additional information concerning chemical and radioactive effluents from the reactors is presented. (D.C.C.)

46207 (DOCKET-50322-21) SHOREHAM NUCLEAR POWER STATION, UNIT NO. 1. Analysis and Comparison with Interim Acceptance Criteria for ECCS for Light Water Reactors. (Long Island Lighting Co., Mineola, N. Y.). 26 Jul 1971. 24p. Dep. NTIS.

Requested additional information concerning performance of the emergency core cooling system is presented. (D.C.C.)

46208 (DOCKET-50341-31) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Technical Information Concerning Conformance to the Interim Criteria for ECCS. (Detroit Edison Co., Mich.). 4 Aug 1971. 25p. Dep. NTIS.

Additional information concerning emergency core cooling system performance requirements is presented. (D.C.C.)

46209 (DOCKET-50342-8) VERPLANCK NUCLEAR FACILITY, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2(Suppl.2): Revised Pages. (Consolidated Edison Co. of New York, Inc., New York). 1 Jun 1971. 272p. (DOCKET-50343-8). Dep. NTIS.

Revised design parameters of the Verplanck Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46210 (DOCKET-50348-22) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 18. (Alabama Power Co., Birmingham). 26 Jul 1971. 186p. (DOCKET-50364-16). Dep. NTIS.

Revised preliminary safety analysis report pages and responses to requests for additional information are presented. Included are revised schematic diagrams of the reactor and plant piping systems and liquid and gaseous waste processing systems data. (H.D.R.)

46211 (DOCKET-50352-16) LIMERICK GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Philadelphia Electric Co., Pa.). 30 Jul 1971. 57p. (DOCKET-50353-16). Dep. NTIS.

Revised and additional data concerning design parameters and operations aspects of the Limerick Power Reactor Units 1 and 2 are presented. (D.C.C.)

46212 (DOCKET-50352-17) LIMERICK GENERATING STATION, UNITS 1 AND 2. Conformance of the AEC Interim Acceptance Criteria for Emergency Core Cooling. (Philadelphia Electric Co., Pa.). 30 Jul 1971. 37p. (DOCKET-50353-17). Dep. NTIS.

Requested additional information concerning performance of the emergency core cooling system is presented. (D.C.C.)

46213 (DOCKET-50354-16) NEWBOLD ISLAND NUCLEAR GENERATING STATION, [UNITS 1 AND 2]. Preliminary Safety Analysis Report, Amendment 9. (Public Service Electric and Gas Co., Newark, N. J.). 26 Jul 1971. 216p. (DOCKET-50355-16). Dep. NTIS.

Revised design parameters of the Newbold Island Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46214 (DOCKET-50358-21) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Draft Detailed Statement on Environmental Considerations. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 19 Jul 1971. 25p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

46215 (DOCKET-50358-22) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 15. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 26 Jul 1971. 72p. Dep. NTIS.

Revised design parameters of the William H. Zimmer Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46216 (DOCKET-50358-23) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 16 (Performance of the ECCS). (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 4 Aug 1971. 41p. Dep. NTIS.

Requested additional information concerning performance of the emergency core cooling system is presented. (D.C.C.)

46217 (DOCKET-50366-13) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 7. (Georgia Power Co., Atlanta). 29 Jul 1971. 120p. Dep. NTIS.

Revised and additional information on the design and operation of Unit 2 is presented. Included is a statement of conformance of the ECCS to AEC interim acceptance criteria. (H.D.R.)

46218 (DOCKET-50367-17) BAILLY GENERATING STATION, NUCLEAR I. Preliminary Safety Analysis Report, Amendment 10. (Northern Indiana Public Service Co., Hammond). 30 Jul 1971. 297p. Dep. NTIS.

Revised design parameters of the Bailly Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46219 (DOCKET-50367-18) BAILLY GENERATING STATION, NUCLEAR I. Preliminary Safety Analysis Report, Amendment 11. (Northern Indiana Public Service Co., Hammond). 6 Aug 1971. 314p. Dep. NTIS.

Requested additional information on the design and operation of Bailly Generating Station, Unit 1, is presented. Included are new data on loading criteria for nuclear steam supply system equipment and the organization plan for the construction management quality assurance program. (H.D.R.)

46220 (DOCKET-50369-13) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Revision No. 8. (Duke Power Co., Charlotte, N. C.). 30 Jul 1971. 75p. (DOCKET-50370-12). Dep. NTIS.

The assumptions, methods, and results of a study of possible flooding conditions occurring on the portion of the Catawba River Basin above the Cowans Ford Dam and Reservoir with respect to effects on the proposed McGuire Nuclear Station are presented. The provisions for an auxiliary source of standby nuclear service water are described, and the performance of the reactor emergency core cooling system is evaluated. (H.D.R)

46221 (DOCKET-50376-19) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Amendment 8. (Puerto Rico Water Resources Authority, San Juan). 6 Aug 1971. 449p. Dep. NTIS.

Revised design parameters of the Aguirre Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

46222 (DOCKET-50382-8) WATERFORD STEAM ELECTRIC STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 4. (Louisiana Power and Light Co., New Orleans). 28 Jul 1971. 117p. (DOCKET-50383-8). Dep. NTIS.

Additional information concerning the quality assurance program for the Waterford Power Reactor Units 3 and 4 is presented. Performance of the containment structure ventilation system during various operations incidents is analyzed. Radioactive effluents from the reactor during operations incidents are calculated. (D.C.C.)

46223 RULES FOR CONSTRUCTION OF NUCLEAR POWER PLANT COMPONENTS. ASME Boiler and Pressure Vessel Code, Section III 1971. New York; American Society of Mechanical Engineers (1971). 614p. Available from American Society of Mechanical Engineers, New York.

Rules of safety governing the design, fabrication, installation, and inspection during construction of nuclear power plant components such as pressure vessels, piping, pumps, and valves are presented. The components for which the rules are specified include those components which are designed to provide a pressure-containing barrier, to act as a pressure-retaining member in the nuclear power system, or to support the reactor core. (H.D.R.)

46224 MULTIPLE PURPOSE USE OF THERMAL CONDENSER DISCHARGES FROM LARGE NUCLEAR SYSTEMS TO SUPPLEMENT INTER-REGIONAL WATER SUPPLY. Jaske, R. T.; Karr, M. H.; Touhill, C. J. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 26-30(1971).

A concept is proposed for siting thermal power plants on a series of canal-lake systems in various regional locations in the U. S. The canal-lake systems would consist of a series of waterways covering an extensive distance and would provide supplementary flow as water supply for cities and for irrigation. The concept is applied to a 990 mile route in Oregon and Nevada, and the technical, economic, and sociological aspects of such systems are discussed. (H.D.R.)

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46225 DAMAGE IN NUCLEAR POWER PLANTS. Feldmann, J. Maschinenschaden; 43: No. 5, 165-71(1970). (In German).

A brief review of damage experience during the construction of nuclear power plants in Germany is presented. Various aspects of damage during the operation of nuclear power plants at home and abroad and a critical review of individual incidents and repairs are included. This shows that repairs can be succesfully carried out on highly activated plant sections within the pressure vessel. The repair times must in such cases be increased tenfold as opposed to comparable repair work not complicated by radiation. It is shown that even serious damage in the nuclear cycles of nuclear power plants has not resulted in danger to personnel or immediate surroundings by radiation. (U.K.A.E.A. Info. Bulletin)

Steam and Power Conversion Systems

46226 BOILER-SUPPORTING STEELWORK FOR DUNGENESS B NUCLEAR POWER STATION. Gifford, A. F. Weld. Metal. Fabr.; 39: No. 7, 248-56(Jul 1971).

The boilers for Dungeness "B" are the once-through type with reheat. They are arranged in the annulus between the pressure cylinder and the pressure vessel membrane, within the concrete vessel, and are mounted in a heavy section stainless steel framework. The complex design and construction problems encountered in the fabrication of this structure, which involves plate thicknesses of up to $3^3/_4$ in., are described and details are given of the welding, cutting, and assembly procedures adopted. (UK)

46227 DESIGN AND COMMISSIONING OF THE BOILERS FOR THE OLDBURY NUCLEAR POWER STATION. Whitehouse, P. R. (John Thomson Design and Contracting Div., Ltd., Wolverhampton, Eng.). Proc. Inst. Mech. Eng. (London); 184: No. 57, 43-62(1969-70).

Design features, pre-commissioning tests, and commissioning experience on the boiler plant of the 600 MW(e) power station at Oldbury, the first nuclear station to adopt once-through boilers, are described. These subcritical boilers were satisfactorily housed inside the concrete pressure vessel. Major problems during commissioning were concerned with tube leaks, safety valve failures, and boiler pressure drops. Operating experience showed the boiler control system to be very reliable. (UK)

Power Reactor Development

Refer also to abstracts 44483 and 44567.

46228 (CONF-710315-23) STANDARDS REQUIRED FOR LMFBR DESIGN AND CONSTRUCTION. Hobson, R. G. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1970]. Contract AT(30-1)-4200. 36p. Dep. NTIS.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

Existing standards that might be applicable to a LMFBR are reviewed. The standards are examined in relation to a 300 MW(e) loop-type plant utilizing hot cell refueling. Actions needed for further standards development are suggested. (H.D.R.)

46229 (EUR-4344) EXPERIMENTAL STUDIES ON THE REACTION OF GRAPHITE WITH STEAM. von der Decken, C. B.; Heinrich, B.; Lange, G.; Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 20p. (In German). NTIS (U. S. Sales Only).

A method for measuring the reaction speed of graphite with steam at temperatures of up to 1100°C is described. The oxidizing agent is diluted with circulated helium. Data are given on the dependence of the oxidation rate on temperature, water concentration and flow rate of the helium and on the type of inert gas. (EURATOM)

46230 (EUR-4350) SIGNIFICANCE OF NUCLEAR ENERGY FOR THE SAFEGUARDING OF ENERGY SUPPLIES. Wessels, Th. (Cologne Univ. (West Germany)). 1969. 101p. (In German). NTIS (U. S. Sales Only).

Economic expansion has caused such an increase in energy demand in the countries of the European Community that imports have reached a high level. Various means of eliminating the risks of a limited interruption in imports are reviewed, in particular the storage and diversification both of types of energy and of sources. Then the safeguarding of supplies within the framework of the long-term development of the energy economy, paying particular attention to nuclear energy is studied. Although there is no doubt that nuclear energy is going to meet an increasing share of electricity demand in the next few decades, this factor will not eliminate the dependence on imports, since the Community does not have sufficient cheap uranium resources nor enrichment plants. Nevertheless, the development of nuclear energy can help to solve the problem of security of supplies, since fission energy increases the range of energy types available, enables supplies to be obtained from countries which are politically and economically stable, and also eases the problems of transport and storage. (EURATOM)

46231 WHAT SHOULD BE REPORTED AS FAST NEUTRON FLUENCE? Koehler, W. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 9: No. 2, 441-9(Jun 1971).

In reports on the results of fast neutron irradiation experiments in reactors, the fluence of neutrons with energies greater than 0.1 MeV should be quoted. Also the energy dependence of the neutron spectrum concerned and of the cross-section of the monitor reaction used for the fluence measurements should be indicated. Ni and Fe (n,p) reactions are proposed as particularly suitable monitors. Using the best cross-section evaluations the apparent cross-sections of these monitors for typical reactor irradiation facilities are calculated and compared with values from the literature. 59 references. (auth)

46232 FAST NEUTRON POWER REACTOR PHENIX. Carle, R.; Megy, J.; Moreau, J. C. Nucl. Eng. Int.; 16: No. 182, 557-9 (Jul 1971).

A brief description is given of Phenix, the first French power station to be equipped with a Na cooled fast reactor. It is a 250 MW(e) integral type reactor with PuO_2-UO_2 stainless steel clad fuel elements. Its role in the French fast reactor development program is discussed. Brief details are given of the reactor, the fuel elements, the present state of progress, and the designing and testing program. (UK)

46233 STRUCTURAL DESIGN AND ASSEMBLY OF THE PHENIX REACTOR. Lagrange, Maurice. Nucl. Eng. Int.; 16: No. 182, 559-63(Jul 1971).

The integrated primary circuit in the PHENIX reactor vessel presents many challenging design and technological problems. Geometrical configurations, materials, mechanical stresses, hydraulic characteristics and thermal behavior were studied in model tests. During assembly careful consideration is given to the large dimensions of the component parts, the avoidance of structural stresses, assembly procedures and continuous fabrication testing and inspection. (auth) (UK)

46234 KERNENERGIE. FAKTEN UND PROGNOSEN FUER INDUSTRIE UND WIRTSCHAFT, MEDIZIN, TECHNIK, UND FORSCHUNG. (Nuclear Energy. Facts and Prognoses for Industry and Trade, Medicine, Technique, and Research). Schmidt, Gerhard. Berlin; Safari Verlag (1970). 248p.

Projections are made about fossil fuels and nuclear energy as energy sources. Also treated are applications of radiation sources in industry, medicine, and research. Emphasized are isotope sources for space exploration and terrestrial purposes, diagnostics, pharmacology, biochemistry, and agriculture. Furthermore, production and utilization of transuranium elements are treated. Power plants in West Germany are analyzed as to economics and safety. Future plans for fast breeders are discussed in detail. In addition, radiation detectors and health physics are treated as well as both national and international legal aspects of nuclear energy production. (H.B.G.)

46235 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1972. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION ON GENERAL STATEMENT, HANFORD REACTORS, AND ENVIRONMENTAL PROGRAM, FEBRUARY 3, 4, AND MARCH 2, 1971. Washington, D. C.: Joint Committee on Atomic Energy (1971). 514p. GPO $2.25.

46236 AEC AUTHORIZING LEGISLATION FISCAL YEAR 1972. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION ON CIVILIAN NUCLEAR POWER PROGRAM, MARCH 4, 1971. Washington, D. C.: Joint Committee on Atomic Energy (1971). 691p. GPO $3.00.

46237 METHODS FOR ASSESSMENT OF NUCLEAR POWER STATION DEVELOPMENT. Jansen, P. J. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 7, 370-2(Jul 1971). (In German).

The institute for applied reactor physics at Karlsruhe is de-

veloping a modern system for long-term assessment of fast breeder development. Simultaneously, long-term decisions about nuclear power plant development in West Germany will become possible. Special emphasis is placed on models underlying the decision-making process. The proposed method of analysis introduces prognostic factors. Moreover, the study represents a contribution to the system analysis of modern technical large-scale projects. Treated are: outline of study, strategies, government support of technical large-scale projects, optimization of breeders, theory of plutonium cost, and uranium enrichment. (H.B.G.)

46238 HTGR REACTOR. Casa, Anna; Fiorentini, Paola. Com. Naz. Energ. Nucl., Notiz.; 16: Nos. 8-9, 67-98(Aug-Sep 1970). (In Italian).

A review of the world's current programs involving gas-cooled high-temperature reactors, broken down by nations and organizations, is presented. Three reactors which have been in operation for some time are discussed. Dragon, Peach Bottom and AVR, as well as the Fort St. Vrain reactor now in an advanced construction stage in the USA, the German THTR for which a construction permit was recently issued, and the main projects planned and in progress. 29 references. (auth)

46239 PROSPECTIVE PEACEFUL USES OF NUCLEAR ENERGY IN THE YEAR 1970. Hill, John. Com. Naz. Energ. Nucl., Notiz.; 16: Nos. 8-9, 49-62(Aug-Sep 1970). (In Italian).

The present situation of nuclear energy is reviewed. The forecasts on energy requirements over the next decade and the ways in which such requirements can be met are discussed with special regard to the British programs. (auth)

Kinetics and Dynamics

46240 (EUR-4335) PEBBLE-BED MECHANICS. PARTS I, II, AND III. Bedenig, D.; von der Decken, C. B.; Huendorf, B.; Rausch, W.; Merten, G. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 100p. (In German). NTIS (U. S. Sales Only).

A classification of direct measurement methods for velocity distribution is followed by a description of the "^{60}Co method." Glass sphere models, their technical structure, and the necessary auxiliary equipment are emphasized. Various test results are given, which demonstrate the field of application of the glass sphere model. After a short comparison of direct and indirect methods, a general survey of the indirect methods is given and particularly of the various possibilities regarding the choice of test spheres. Finally, the "circulated spheres method," which is regarded as the best, is described in detail and demonstrated on a provisional THTR core model. A report is given on ordering effects in cores and sphere discharge tubes and on their cause and explanation. This follows general remarks on ordering effects in sphere systems. From the analyses of the ordering effects, based on numerous experiments, ways can be found of avoiding undesirable ordering effects. (EURATOM)

46241 (NP-18890) REX: A DIGITAL CODE FOR CALCULATION OF DYNAMIC PROBLEMS OF A FAST REACTOR. Kuczera, B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Feb 1971. 22p. (In German). Dep. NTIS (U. S. Sales Only).

A second version of the REX-Code for calculating reactor dynamics has now been provided for Na cooled fast reactors. Four sample problems have been selected in order to demonstrate the kinds of reactivity disturbances (including a simultaneous change in the coolant data) of which the transient behavior of the reactor power and the corresponding temperatures can be calculated. One of the above mentioned sample problems compares both the results of the REX-Code calculation and an equivalent FORE-Code calculation. 5 references. (auth)

Control Systems

Refer also to abstracts 46294 and 46334.

46242 (KURRI-TR-75, pp 2-14) PRESENT STATUS OF COMPUTER CONTROL OF NUCLEAR REACTOR. Hara, Masao; Shinohara, Yoshikuni (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Computers are used mainly for the collection and statistical processing of measured data in research reactors, and for automating the operation of power reactors. Therefore, they require system reliability and time sharing functions. The utilization of computers in foreign countries is reviewed. The purpose of application, number of input signals, and computer systems for reactor plants are summarized. In view of function, they are applied to performance calculation, monitoring of core failure, automating of operations such as reactor start-up, zone control, turbine start-up, measurement of power distribution in a core, control of fuel exchange, and data processing. Reliability improvement is required for the performance of control computers in the future. To realize this, adoption of redundant systems and back up instrumentation are examined. (Japan)

46243 (KURRI-TR-75, pp 47-52) ON LINE APPLICATION OF A COMPUTER TO JPDR-II. Shinohara, Yoshikuni (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

JPDR-II, the improved version of a test reactor in Japan Atomic Energy Research Institute, is under modification. For on-line data processing of JPDR-II, a small computer system which consists of digital computers PB-250, DDP-416 and peripheral equipments is to be used. The peripheral equipments are dc-amplifiers, a multiplexer, an A-D converter, a high-speed buffer, an interface logic system, a digital plotter, flexowriters, a high-speed punch, a high-speed reader, a buffer register, and a D-A converter. Software of the system is divided into three items: (a) data acquisition and edition; (b) data processing; and (c) data recording and display. Main jobs of data processing are thermal calculation of the plant, performance computation of the reactor core, balance calculation of reaction and various data analyses. Since the PB-250 computer is obsolete, it can not perform so many jobs as required for steady state operation of JPDR-II. Therefore, the proposed system must be confined only to preliminary jobs. (Japan)

46244 (KURRI-TR-75, pp 60-75) GENERAL CONSIDERATION ON OPTIMAL CONTROL THEORY. Suda, Nobuhide (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Those results of research useful for on-line computer control as well as those items which should be developed are reported. Topics are listed as follows: (1) application of the results of research on modern control theory; (2) concept of hierarchy for optimal control of nuclear reactors; and (3) procedure to process complex problems. The first topic includes linear optimal predication, and linear and non-linear control via state variable feedback and multi-variable control. The second topic is the concept of hierarchy in which optimal control problems are divided into several levels. At first, optimal control is performed within each of the levels respectively, and then the whole system is optimized through coordination between the levels. The last topic discusses the procedure to obtain quantitative answers rather than qualitative ones for optimal control of complex systems. (Japan)

46245 (KURRI-TR-75, pp 76-82) OPTIMAL CONTROL OF NEUTRON FLUX DISTRIBUTION. Sato, Kohei (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Problems on neutron flux distribution and output distribution density during steady operation are described. As far as critical condition is satisfied, the neutron flux distribution within a reactor can take various modes of operation in accordance with properties and distribution of fuel, moderator, or controller. Therefore, the mode of neutron flux distribution, which minimizes or maximizes the evaluation function defined according to each purpose, can be realized in cases listed as follows; (a) minimum critical mass; (b) most efficient distribution of the controller; (c) smoothing of the output distribution; (d) maximum fuel conversion factor; and (e) maximum burnup. The methods to determine the neutron flux distribution using optimal control theory are illustrated. (Japan)

46246 (KURRI-TR-75, pp 83-5) PRESENT STATE OF RESEARCH ON BURNUP OPTIMIZATION OF POWER REACTORS. Kawai, Toshio (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The present state of research on burnup optimization as one

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of the problems for optimal control of power reactors is discussed. Main theses discussed are as follows: (1) analysis of continuous reactor refueling; (2) burnup optimization of continuous scattered refueling; (3) application of dynamic programming to fuel management; (4) optimization of nuclear reactor fuel recycle via linear and quadratic programming; (5) models for burnup optimization study of power reactors; (6) control rod optimization in two region reactors; (7) control rod optimization using dynamic programming; (8) PWR optimal core management and reactivity profiles; and (9) core optimization from the view point of neutron flux distribution. (Japan)

46247 (KURRI-TR-75, pp 86-7) COMMENT ON BURNUP CONTROL. Kiyose, Ryohei (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

To optimize burnup control of power reactors, optimization must be considered both for long-term reaction control and refueling. Though the situation differs considerably between batch refueling and continuous refueling, only the former case is discussed. In this case, it is preferable to divide a reactor into many small areas, where each function can be considered a lumped constant, so that characteristics of the control problem can be easily analyzed. (Japan)

46248 (KURRI-TR-75, pp 111-13) EXAMPLES OF COMPUTER APPLICATION TO REACTOR CONTROL. Fujine, Shigenori (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Computers applied to control reactors which are now operating in Japan, England, Canada, Sweden, USA, Germany, Italy, France, Norway, Denmark, and Switzerland are listed. The list gives names of plants, type and output of the reactors, the computers used, memory capacity, usage of the computers, and the year of installation. The list includes fifty-five reactors. The computers perform various jobs of monitoring, logging, data display, alarm, data analysis, data recording, control, optimization, etc. (Japan)

46249 INSTRUMENTATION, CONTROL, AND MONITORING SYSTEMS. Chapelot, M. Nucl. Eng. Int.; 16: No. 182, 577-80(Jul 1971).

Special instrumentation and control systems developed for the Phenix station, particularly in relation to fast reactivity response, fuel integrity, and sodium coolant, are discussed. Descriptions are given of both nuclear and thermal monitoring systems, methods for detection of failed fuel elements, electromagnetic flowmeters, and sodium level gauges. The role of computers, particularly for monitoring of reactor and electrical generating plant circuitry, is briefly outlined. The supply of electricity to the station auxiliaries is discussed. (UK)

Shielding

46250 REACTOR SHIELDING IN THE COMMISSARIAT A L'-ENERGIE ATOMIQUE. Devillers, C. (CEN, Fontenay-aux-Roses, France). Nucl. Eng. Des.; 15: No. 3, 309-18(Apr 1971).

Reactor shielding studies in France have largely forsaken semi-empirical methods in favor of Monte Carlo and discrete ordinates computer calculations. Some of the codes were obtained from the United States but many of the codes discussed have French origin. The cross section sets used are also discussed. The results of neutron transport calculations were compared with specific experimental data obtained in the HARMONIE reactor thermal column. Monte Carlo calculational results are also given of neutron streaming in the PHENIX fast breeder reactor. 35 references. (auth)

46251 TODAY'S APPROACHES TO REACTOR SHIELDING PROBLEMS. Nicks, R.; Penkuhn, H. (EURATOM-CCR, Ispra, Italy). Nucl. Eng. Des.; 15: No. 3, 294-308(Apr 1971).

A general lay-out of today's shielding problems, their peculiar features and their approach to solution are presented. Particular attention is paid to the European situation, and more specifically to the Ispra-CCR activity. The panorama covers theoretical, applied and experimental shielding physics. 27 references. (auth)

46252 SHIELDING FOR ADVANCED REACTORS IN THE UNITED STATES. Maienschein, F. C.; Clifford, C. E.; Mynatt, F. R.; Abbott, L. S. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.; 15: No. 3, 241-64(Apr 1971).

A shielding technology emerging in the United States for advanced reactor systems is based on detailed solutions of the Boltzmann transport equation with improved versions of the discrete ordinates and Monte Carlo calculational methods. These improved techniques, together with the availability of larger and faster computers and an increasing body of accurate cross-section data, will reduce shield design uncertainties and thereby alleviate excessive costs associated with over-conservatism. The need for such a refined technology becomes imperative as the designs for Liquid Metal Fast Breeder Reactors and reactors for application in space become more advanced. In efforts to provide shield design methods required for these reactors, work is being concentrated on adapting the discrete ordinates and Monte Carlo techniques to the unique characteristics of each system and on improving the basic nuclear data for specific materials used in the systems. The validity of the techniques and data, as adapted, is being tested experimentally, with more emphasis on benchmark-type measurements than on mockup-type measurements. 120 references. (auth)

Cooling Systems

Refer also to abstracts 44728 and 44732.

46253 (BNWL-B-82) COBRA-III: A DIGITAL COMPUTER PROGRAM FOR STEADY STATE AND TRANSIENT THERMAL-HYDRAULIC ANALYSIS OF ROD BUNDLE NUCLEAR FUEL ELEMENTS. Rowe, D. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 77p. Dep. NTIS.

The COBRA-III computer program computes the flow and enthalpy in rodbundle nuclear fuel element subchannels during both steady state and transient conditions. It uses a mathematical model that considers both turbulent and diversion crossflow mixing between adjacent subchannels. Each subchannel is assumed to contain one-dimensional, two-phase slip-flow. The two-phase flow structure is assumed to be fine enough for local void fraction to be a function of enthalpy, flow rate, heat flux, pressure position and time. Steady-state two-phase flow correlations are assumed to apply to transients. The mathematical model neglects sonic velocity propagation; therefore, it is limited to transients where the transient times are greater than the time for a sonic wave to pass through the channel. A simplified transverse momentum equation is also used to simplify the numerical solutions. This simplification neglects the transverse temporal and spatial acceleration and therefore gives instantaneous response of the diversion crossflow to changes in subchannel pressure gradient. The equations of the mathematical model are solved by using a semi-explicit finite difference scheme. The scheme is stable for all time and space steps; however, reasonably small steps are required to obtain accurate solutions. This scheme also gives a boundary-value flow solution for both steady state and transients where the boundary conditions are the inlet enthalpy, inlet mass velocity, and exit pressure. The features of COBRA-III are summarized. 15 references. (auth)

46254 (EUR-4337) STUDIES ON HEAT TRANSFER CONDITIONS ON PEBBLE BEDS IN CORE MODELS. von der Decken, C. B.; Mauersberger, R.; Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 44p. (In German). NTIS (U. S. Sales Only).

The analogy between heat and material exchange was utilized in tests to elucidate the heat transfer conditions in a gas-cooled pebble-bed reactor. Particular importance was attached to the determination of the place-dependence of the coefficients of heat transfer. The theoretical principles underlying the measuring methods and the experimental results obtained are described. (EURATOM)

46255 (EUR-4338) THTR REACTOR GAS CLEANUP STUDIES. von der Decken, C. B.; Engel, R.; Lange, G.; Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 34p. (In German). NTIS (U. S. Sales Only).

Investigations have demonstrated that the gas can be cleaned by chemical bonding of the impurities (H_2, O_2, CO, CO_2 and H_2O). Good reaction and initial concentration values are attained. The oxidizer and water filter operate at about 260°C. At this temperature the CO_2 filter can only be reacted up to 4%, but if the temperature is raised to 350°C reactions of up to 60% are obtained. The CO_2 and water filters can support a 100:1 load and the oxidation filter 200:1. (EURATOM)

46256 (EUR-4343) TESTING OF HIGHLY STRESSED PLAIN BEARINGS USED FOR EXTREME REACTOR CONDITIONS. Boehlo, D.; Hoffmann, D.; Werth, H. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 24p. (In German). NTIS (U. S. Sales Only).

On the basis of the tests carried out, initial recommendations are made as to the design of highly stressed plain bearings in an ultrapure helium atmosphere. Generally speaking, the conditions of friction and wear in very pure helium are totally different from those in air. In all the tests MoS_2 proved to be extremely helpful in reducing the friction coefficient and wear. For example, it was only due to the effect of the MoS_2 that the bearings ran satisfactorily, i.e., all the bearing partners not treated with Molycote, except those made of PAN-bronze, did not complete the normal test program without seizing marks being produced. In the case of PAN-bronze the coefficient of friction was reduced 15-fold by the application of Molycote compound X15 to the bearings. This combination, with a clearance of 0.1 to 0.15 mm, proved to be the best, the coefficient of friction lying between $\mu = 0.022$ and 0.028 with a specific bearing stress of $p = 92.4$ kp/cm^2. During the normal test program the coefficients of friction of all the other combinations treated with Molycote were considerably higher but no seizing or wear was observed. A very high degree of wear was observed in the case of untreated bearings, and bushings and journals contained deep grooves. Treatment with MoS_2 is therefore essential for reliable operation. (EURATOM)

46257 (ORNL-TM-3428) ESTIMATED COST OF ADDING A THIRD SALT-CIRCULATING SYSTEM FOR CONTROLLING TRITIUM MIGRATION IN THE 1000-MW(e) MSBR. Robertson, Roy C. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 28p. Dep. NTIS.

Controlling tritium migration to the steam system of the 1000-MW(e) reference design MSBR power station by interposing a $KNO_3-NaNO_2-NaNO_3$ salt-circulating system to chemically trap the tritium would add about $13 million to the total of $206 million now estimated as the cost of the reference plant if Hastelloy N is used to contain the $^7LiF-BeF_2$ salt employed to transport heat from the fuel salt to the nitrate–nitrite salt, and about $10 million if Incoloy could be used. The major expenses associated with the modification are the costs of the additional heat exchangers ($9 million), the additional pumps ($5 million), and the $^7LiF-BeF_2$ inventory ($4.8 million). Some of the expense is offset by elimination of some equipment from the feedwater system ($2 million), through use of less expensive materials in the steam generators and reheaters (about $2 million), and through an improved thermal efficiency of the plant (worth about $1 million). In addition to acting as an effective tritium trap the third circulating system would make accidental mixing of the fuel and secondary salts of less consequence and would simplify startup and operation of the MSBR. A simplified flowsheet for the modified plant, a cell layout showing location of the new equipment, physical properties of the fluids, design data and cost estimates for the new and modified equipment are presented. (auth)

46258 CIRCUITS AND MAIN COMPONENTS. Befre, J. L. (CEA, Saclay, France); Delisle, J. P.; Robin, M. G. Nucl. Eng. Int.; 16: No. 182, 567-70(Jul 1971).

A description is given of the studies and tests which led to the choice of design for the pumps, intermediate heat-exchangers and steam generators for PHENIX. Design details of the components are presented. Problems encountered during the development and fabrication are discussed. (UK)

46259 CALCULATION OF THE HYDRODYNAMIC CHARACTERISTICS OF ROD CLUSTERS. Subbotin, V. I.; Ushakov, P. A. (Inst. of Physics and Energetics, Obninsk, USSR). Heat Transfer-Sov. Res.; 3: No. 3, 157-76(May-Jun 1971).

Methods of calculating averaged hydrodynamic variables in laminar and turbulent isothermal flow of a liquid in reactor fuel rod clusters are briefly examined. The techniques used to calculate rod clusters with large value of S/d are analyzed in detail. Most suitable in the case is a method based on an improved version of Rothfus' method for analyzing annular ducts. Formulas are recommended for calculation of the friction coefficients in rod clusters. 24 references. (auth)

46260 VOPROSY TEPLOFIZIKI YADERNYKH REAKTOROV. VYPUSK 3. (Physics of Heat Transfer in Nuclear Reactors. Number 3). Subbotin, V. I. (ed.). Moscow; Atomizdat (1971). 112p.

A collection of 15 papers representing the results of investigations in heat exchange in flowing liquids and the thermal-physical properties of materials of particular interest to nuclear reactor engineers is presented. Attention is given to the subject of heat exchange for liquid flow in pipes over a broad range of pressures and velocities of circulating coolants. Data are given from experiments on boiling mercury under differing conditions of wetting of the heat exchange surface. Mechanisms of exchange on gas-liquid streams with dispersed-circular flow, and experimental data on hydraulic resistance, with respect to the distribution of local velocities and concentrations of both phases are presented. The geometric characteristics of liquid films adjacent to tube walls are explored. Two methods are proposed for measuring heat conductivity coefficients at high temperatures, and using samples of small dimensions. A number of papers are given to the subject of thermal-physical parameters of a heat-evolving element in a fuel element assembly. Problems regarding sonic vibrations in two-phase media and of admission and outlet of ultrasonic vibrations in a power installation operating at high temperature are discussed. (K.S.W.)

46261 TRANSIENT TEMPERATURE DISTRIBUTION IN THE REACTOR VESSEL WALL BY FAILURE OF A REACTOR COOLING PUMP. Eberwein, Josef (Siemens Aktiengesellschaft, Erlangen, Ger.). Nucl. Eng. Des.; 16: No. 2, 137-50(1971).

A general formula was developed for calculation of the transient temperature distribution in a reactor vessel wall if the water temperature drops suddenly as a consequence of a reactor cooling pump failure. The functions of the formula are plotted in diagrams for a convenient calculation of the transient temperature distribution influenced by different sources of gamma ray energy deposition. The additional mechanical stresses in the wall of the reactor vessel which occur suddenly can be proved easily with the transient temperature distribution. (auth)

46262 HYDRODYNAMIC BEHAVIOR OF A BOILING WATER REACTOR. Wagner, H. (Technische Hochschule, Garching, Ger.). Nucl. Eng. Des.; 16: No. 2, 169-78(1971). (In German).

The hydrodynamic behavior of a boiling water reactor under transient conditions is described by an analytical model including nonlinear feedbacks of the time dependent system pressure and water level variations. The inhomogeneous steam–water flow in the core and riser zone is simulated in one dimensional form, while in the coolant recirculation loops temperature perturbations are considered to influence the reactor core subcooling by delay time of the coolant flow. The effect of pressure feedback on the hydrodynamic behavior of a boiling water reactor following an excursion of reactor power is shown. In addition, results obtained from a boiling water test facility are compared with results obtained by calculations. (auth)

Fuels

Refer also to abstract 44664.

46263 (BNWL-SA-3865) RESULTS FROM USAEC PLUTONIUM UTILIZATION PROGRAM CONDUCTED BY BATTELLE-NORTHWEST. Dawson, F. G.; Freshley, M. D.; Liikala, R. C.; Prezbindowski, D. L.; Uotinen, V. O.; Van Tuyl, H. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [Apr 1971]. 46p. (CONF-710616-1). Dep. NTIS.

From Panel on plutonium recycling in thermal power reactors; Vienna, Austria (21 Jun 1971).

Significant results in fuels development and reactor physics from the program for utilization of plutonium in light water power reactors are summarized. Pellet-type UO_2-PuO_2 fuel is considered the reference design with packed particle fuel the most promising alternate. The fuel fabrication and properties evaluations are reviewed, and the criticality and other physics parameters of plutonium fueled systems are examined. 51 references. (H.D.R.)

46264 (EUR-4339) RESEARCH INTO THE INFLUENCE OF THE FUEL DISTRIBUTION ON THE NEUTRON SPECTRUM IN SPHERICAL FUEL ELEMENTS. Bock, H. J. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 24p. (In German). NTIS (U. S. Sales Only).

In spherical fuel elements the fissionable material can be arranged in variously shaped cavities in the form of coated particles. For certain possible layouts, such as hollow central cylinders, the cylinder ring of different diameters, or the homogeneous fuel distribution in the sphere, thermal neutron spectra are given and from them the cross-sections of a few important isotopes obtained by averaging. It is thus possible to determine the influence of the fuel arrays on the n.f. values. (EURATOM)

46265 (EUR-4340) DEVELOPMENT OF FUEL ELEMENTS FOR THE THORIUM HIGH-TEMPERATURE REACTOR THTR. Spener, G.; (and others) (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 230p. (In German). NTIS (U. S. Sales Only).

Various techniques were studied to determine the best method for producing uranium and uranium–thorium carbide particles. The gyrating bowl technique proved to be the best of the powder metallurgical processes, being even more economical for small

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batches than the sol-gel technique developed for uranium–thorium particles, where the U: Th ratio is in the range of 1: 5–1: 10. Both processes result in green compact particles of UO_2 + C or (U, Th)O_2 + C, which are then reacted and sintered to carbide particles of 300–400 microns in diameter or else melted at 2500°C. The particles were coated with pyrocarbon or silicon carbide in a fluidized bed furnace with a capacity of 1 kg of carbide particles at a temperature of 1400–2000°C. Several structures were developed and tested to produce duplex and triplex layers. Coating in underpressure proved a particularly good method. Graphite spheres with different cavity configurations were studied for the production of fuel elements with loosely packed fuel particles. The development of a process for the series production of hollow spherical fuel elements (wallpaper type) was largely completed. The main stages in this process are the hollowing out of the sphere through a small machining aperture, the spreading of an even layer of particles over the inner wall of the sphere using tumblers and then the filling in of the sphere with graphite powder. Various types of graphite with particularly good qualities were developed for the graphite matrix used in the production of compacted fuel elements. A process was also studied for coating the particles with compacted graphite powder. Because of the high thermal conductivity of the graphite matrix and the reduction of the thickness of the particle-free outer shell to about 5 mm, it was possible (a) greatly to improve the heat removal and (b) to increase the amount of heavy metal introduced to 22 g. After their development has been completed the compacted fuel elements will be the most economical types. Appropriate combustion and separation processes were studied and tested for reprocessing the considerable amounts of uranium contained in the particles and elements produced during the above operations. The particles, both coated and uncoated, as well as the graphite used and the various types of fuel element were tested following standardized methods. In addition, various special studies were carried out. Especially important was the development of an activation test (xenon diffusion test) for the preselection of samples for further reactor tests at high burn-up. The test enabled a distinction to be made between the fission gas originating inside the particles and that from the uranium present on the surface. A series of graphite, particle and fuel element samples were produced and sent off for reactor irradiation tests. Work was carried out at the same time on developing irradiation capsules and on preparing hot cell studies. (EURATOM)

46266 (EUR–4345) METHODS FOR NON-DESTRUCTIVE MEASUREMENT OF THE BURN-UP OF REACTOR FUEL ELEMENTS. Bachus, K. P.; von der Decken, C. B.; Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 60p. (In German). NTIS (U. S. Sales Only).

The methods reviewed are being studied more closely with regard to their potential application to the nondestructive measurement of the burnup of spherical fuel elements such as those to be used in the THTR. It is found that the reactivity measuring method in a critical assembly and the gamma-spectroscopic determination of the content of fission products offer considerable advantages over most other methods. (EURATOM)

46267 (GEAP–13112) THERMAL RESPONSE AND CLADDING PERFORMANCE OF AN INTERNALLY PRESSURIZED, ZIRCALOY–CLAD, SIMULATED BWR FUEL BUNDLE COOLED BY SPRAY UNDER LOSS-OF-COOLANT CONDITIONS. Duncan, J. D.; Leonard, J. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr 1971. Contract AT(10-1)-1230. 149p. Dep. NTIS.

The first full-length, electrically heated, 49-rod, Zircaloy-clad simulated BWR fuel bundle with internally pressurized rods was spray cooled under loss-of-coolant conditions. The heater rods were internally pressurized with argon to simulate fission product gas inventory. The temperature response, perforation, and oxidation of the bundle cladding is described. Many perforations and severe rod distortions occurred near the center of the bundle. Nevertheless, spray cooling, which was initiated at a maximum cladding temperature of 1920°F, was effective in limiting cladding temperatures to approximately 2250°F. Electrical failure of 10 heater rods complicated the interpretation of the results, and it is estimated that the maximum temperature would have been less than 2310°F had the failures not occurred. The maximum coolant flow area reduction around a single rod caused by local perforations was 50%. However, this flow area reduction apparently did not appreciably impair the effectiveness of the spray cooling system. Analysis performed using current loss-of-coolant techniques and heat transfer coefficients derived from stainless steel-clad bundle tests predicted individual cladding temperatures with reasonable accuracy. (16 references) (auth)

46268 (ORNL–TM–3384) PERFORMANCE OF SPHERE-PAC AND PELLETIZED (U,Pu)O_2 DURING SEVERE OVERPOWER TRANSIENTS. Cox, C. M.; Cuneo, D. R.; Manthos, E. J. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 30p. (CONF-710414–8). Dep. NTIS.

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971).

Six fuel pins containing unirradiated sol-gel-derived (U,Pu)O_2 were subjected to power transients at the Transient Reactor Test Facility (TREAT). No failure occurred even though 50 vol % of the fuel melted in the peak power regions of two Sphere-Pac pins. Although the fuel pins showed no significant dimensional changes, neutron radiographic and destructive examinations showed extensive fuel relocation within the cladding. This included fuel column separations, fuel densification during cooling from a molten state, and axial migration of fuel and perhaps of large bubbles of adsorbed gases in the molten fuel. There was evidence that a gap formed between the Sphere-Pac fuel and cladding by a combination of sintering and shrinkage during cooling from the melt. The influence of fuel column separations on length changes tended to be offset by sintering and shrinkage. Pellet fuel pins showed occasional separations at pellet interfaces, apparently due to a ratchetting mechanism. Comparison with other data reported indicates that, for the types of transients considered, there is no difference between the performance of pellet or Sphere-Pac fuel of the same smear density and sol-gel and coprecipitated pellets behave equivalently. 17 references. (auth)

46269 (TID–25756) SENSITIVITY OF FUEL PIN TO BEHAVIOR TO VOID SWELLING AND IRRADIATION CREEP OF STAINLESS STEEL. Boltax, A.; Soffa, T. P.; Biancheria, A. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). [1971]. Contract AT(30-1)-4210. 5p. Dep. NTIS.

Analytical studies of the behavior of stainless-stee-clad, mixed-oxide fuel pins with the OLYMPUS and CYGRO–F computer codes have revealed the significance of void swelling and irradiation creep of stainless steels on the burnup capability of this LMFBR fuel system. These studies revealed the major effects of fuel pellet and/or fuel smear density, fluence-to-burnup ratio, and cladding temperature on the dimensional behavior of fuel pins. 3 references. (auth)

46270 (TID–25757) SIMULATION OF INTERCHANNEL COOLANT MIXING IN A SODIUM COOLED REACTOR FUEL ASSEMBLY. Carelli, Mario D. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). [nd]. Contract AT(30-1)-4210. 3p. Dep. NTIS.

Coolant mixing in reactor assemblies has been widely studied through experiments in models, employing air or water and mass tracer (salt, dye, chemical or radioactive tracer, electrolyte) or heat tracer (stream of fluid at different temperature, heated elements) techniques. A simulation problem is faced in applying the results of the past experiments or planning new experiments for Liquid Metal Fast Breeder Reactors (LMFBR) conditions. For example, mixing experiments will be performed on models featuring 1/6 sector of a 217 pin assembly and employing a mass tracer technique in air. The experimental conditions must be defined and a correlation is needed between the reactor (sodium) conditions and the mixing data obtained in fluids much easier and cheaper to handle than sodium. The method presented allows calculation of the actual mixing flowrate from the experimental values. However, it applies to bare rod bundles only, since the turbulent mixing component alone is considered. In the case of gridded assemblies, for example, another component due to flow scattering must be added which, being purely hydraulic, needs no correction. The total mixing flowrate is determined by evaluating separately the turbulent and flow scattering components and applying a derived equation to the turbulent part alone. (auth)

Auxiliary and Emergency Systems

Refer also to abstract 46267.

46271 (EUR–4342) EXPERIMENTAL RESULTS WITH THE INDIVIDUALIZER DISC-SCRAP SEPARATOR COMBINATION. von der Decken, C. B.; Faber, R.; Huendorf-Richter, B.; Mauersberger, R.; Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 17p. (In German). NTIS (U. S. Sales Only).

The tests proved that the combination, fulfills the necessary requirements. This was shown to be the case even under the most adverse test conditions. The first part of the development work on one of the most important components of the THTR charging facility has thus been completed. As a continuation of the work, the correct

functioning of a prototype combination is to be demonstrated. (EURATOM)

46272 (RDT-E-1-13-T) VALVE, ISOLATION, BUTTERFLY TYPE, RUBBER SEATED CONTAINMENT HEATING AND VENTILATING SYSTEMS FOR LIGHT WATER NUCLEAR POWER PLANTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1970. 12p. RSO.

Requirements for wafer and flanged butterfly valves used as isolation valves in light water reactor containment vessel air recirculation systems are presented. (H.D.R.)

46273 (WCAP-7665) PWR FLECHT: (FULL LENGTH EMERGENCY COOLING HEAT TRANSFER). Final Report. Cadek, F. F.; Dominicis, D. P.; Leyse, R. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div. Idaho Nuclear Corp., Idaho Falls). Apr 1971. Contract AT-(10-1)-1230; Subcontract S-7045. 276p. Dep. NTIS.

The objective of the PWR FLECHT (Full Length Emergency Cooling Heat Transfer) program was to obtain experimental reflooding heat transfer data under simulated loss-of-coolant accident conditions for use in evaluating the heat transfer capabilities of pressurized water reactor emergency core cooling systems. Eighty-seven valid runs which investigated the effects of peak power, power decay rate, maximum initial clad temperature, constant and variable flooding rates, inlet coolant subcooling, pressure, flow blockage, borated coolant, and clad material were performed. The results of the entire PWR FLECHT program are summarized. The test results reported include transient heat transfer coefficients and clad temperatures at different radial and axial locations, axial and radial pressure drop data, local coolant temperature and measurements of carry-over water. The effects of each of the test parameters on heat transfer behavior are discussed and heat transfer correlations as a function of system parameters are presented. Results of the heater rod development and materials evaluation tasks are also included. The test results have verified the basic assumptions used in current reactor loss-of-coolant accident analysis. In particular, the effectiveness of bottom flooding and the importance of liquid entrainment as a heat transfer mechanism have been demonstrated. (10 references) (auth)

46274 FUEL AND SPECIAL HANDLING FACILITIES FOR PHENIX. Benoist, E. (CEA, Cadarache, France); Boulinier, C. Nucl. Eng. Int.; 16: No. 182, 571-6(Jul 1971).

Handling operations on PHENIX will usually be performed during reactor shutdown periods, and will be of short duration because of the small number of components involved. Descriptions and flow-diagrams are presented for handling procedures relating to control rods, guide tubes, fuel, fertile and shielding assemblies. These include: the preparation of new elements; transfer to the reactor; loading and unloading of the reactor; outside storage in drum; conditioning, dismantling of spent elements in hot cell; and dispatch to the reprocessing plant or to solid waste storage area. The systems for handling the primary pumps and exchangers, the control rods and mechanisms, the transfer arm and other irradiated devices, are also described. They include: special flasks; storage and wash down pits; and the dismantling cell. Preliminary and full scale prototype tests of fuel handling devices showed the viability of the solution chosen. (auth) (UK)

Operation and Economics

Refer also to abstract 46322.

46275 (DUN-SA-167(Rev.1)) COMPUTERIZED TESTING OF REACTOR SYSTEMS. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash.). [1971]. 11p. Dep. NTIS.

Computerized testing techniques for operational and performance testing of nuclear reactor systems are improving the accuracy of testing, reducing dependence upon operator skill for adequate test results, and making possible reduction of as much as ten to one in the time required for such testing. These techniques, made possible by the availability of the tremendous computing power of minicomputers in small relatively low cost packages, are opening up new avenues for testing which will result in improved reactor operating efficiency. (auth)

46276 (ORNL-TM-3456) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR MAY 1971, NO. 27. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 76p. Dep. NTIS.

The development of methods for the reprocessing and fabrication of LMFBR fuels is reviewed. Problems of irradiated fuel transport to the processing facility, the dissolution of the fuel and the chemical recovery of the PuO_2-UO_2 values, the containment of volatile fission products, product purification, preparation of fuel material by the sol-gel process, conversion of fuel processing plant product nitrate solutions to solids suitable for shipping and for fuel fabrication, fuel fabrication of sol-gel materials, and fuel evaluation studies, both in-pile and out-of-pile are described. Pertinent experimental results are presented. (auth)

Safety and Siting

Refer also to abstract 46253.

46277 (CONF-710315-12) DEVELOPMENT AND USE OF STANDARDS FOR THE LMFBR. Henrie, J. O.; Durand, R. E. (Atomics International, Canoga Park, Calif.). 9 Mar 1971. 15p.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

The development of LMFBR standards at Atomics International is reviewed. Plans for developing fast breeder reactor standards are described. Some of the practices used in assuring a balanced implementation of standards are discussed. (D.C.C.)

46278 (CONF-710427-2) THERMAL DISCHARGES: AN OVERVIEW. Kolflat, Tor D. (Sargent and Lundy, Chicago, Ill.). [20 Feb 1971]. 25p.

From American power conference; Chicago, Ill. (20 Apr 1971).

A discussion of thermal discharges in relation to electrical power generation is presented. The various aspects of the cooling water discharge problem examined include: the steam power cycle heat rejection; total heat rejection from heat energy sources; impact of heat on the environment; beneficial applications of heat; environmental legislation; cooling devices and methods; and cooling system costs. A list of selected references related to thermal discharges is included. (H.D.R.)

46279 (GEAP-13193(Add.)) SCALE MODEL TESTS OF FISSION-PRODUCT REMOVAL IN SUPPRESSION POOLS. ADDENDUM. Siegwarth, D. P.; Siegler, M. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1971. Contract W-7405-eng-26; Subcontract 2837. 16p. Dep. NTIS.

The effect of sodium metavanadate on the absorption of nonradioactive methyl iodide in a $1/10{,}000$ scale-model pressure-suppression pool and the ability of the pool to absorb methyl iodide injected into the drywell in the absence of the pressure vessel blowdown driving forces were investigated at simulated loss-of-coolant accident conditions. The presence of a 1.8×10^{-3} molar solution of sodium metavanadate in the model suppression pool did not significantly affect the absorption efficiency of the pool for methyl iodide. About 50 to 60% of the methyl iodide injected into the model drywell was absorbed by the suppression pool when a pump was used to circulate the drywell gas through the pool. Under conditions of natural circulation or with a steam-bleed into the drywell, about 75 to 90% of the methyl iodide remained in the drywell. (auth)

46280 (KURRI-TR-75, pp 88-98) HARDWARE AND SOFTWARE FOR COMPUTERS FOR OPTIMAL CONTROL OF REACTORS. Murata, Hiroshi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Hardware and software requirements for computer systems applied to reactors and a proposed reactor control system which comprises a number of small computers (mini-computers) are described. As for the hardware, detailed discussion is made with regard to transducers, A-D converters, multiplexers, monitor output and control input devices, data storage devices and control signal generation mechanisms. The software should include such principal routines as prestart checkup-startup, steady operation, shutdown, and failure handling. The proposed system consists of many mini-computers, each of which is used as a member of various processors or controllers and operates concurrently. Typical specifications for the mini-computer are as follows: core memory: 4 KW-32 KW; cycle time: 0.7-2.0 μsec; instructions: 20-40; index: 2-8; software: compiler or assembler; price: $11,000-14,000. The unique features of the system are described in contrast with time sharing systems. (Japan)

46281 SITE WORK FOR THE PHENIX PLANT. Labat, M. Nucl. Eng. Int.; 16: No. 182, 564-6(Jul 1971).

A description is given of the civil engineering and erection work carried out at the PHENIX power plant site. Site preparation, main substructure excavation, foundation and erection work are considered. (auth) (UK)

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46282 KINETIC ENERGY OF THE FUEL–SODIUM REACTION. COMPARISON OF TWO MATHEMATICAL METHODS. Thurnay, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 7, 362-4(Jul 1971). (In German).

To calculate the effect of fuel–sodium reactions, the method proposed by Hicks and Menzies is compared with that by Randles. Diagrams are presented which show that kinetic energy, efficiency, and maximal steam pressure of a Hicks–Menzies process are significantly lower than those of a corresponding Randles process. Therefore, the rate of energy transmission between fuel and sodium becomes highly important. The infinitely fast energy transport of Hicks–Menzies produces kinetic energy which is 7 to 70 times higher than that obtained with the finite rate of heat conduction proposed by Randles. For calculations of energy transmission rates between two hot liquids of different temperatures, the nuclear research center at Karlsruhe is developing a microscopic model with a corresponding computer program. (H.B.G.)

46283 METHODS FOR EVALUATING EFFECTS OF TRANSIENT CONDITIONS IN HEAVILY LOADED AND EXTENSIVELY REGULATED STREAMS. Jaske, R. T.; Templeton, W. L.; Boutant, C. C. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 31-9(1971).

New methods for prediction of dispersion are illustrated. They include high-speed photography of intermittent dye releases by using special light filtering to enhance imagery, use of infrared imagery, computer processing of imagery, and the development of evaluation methods which are superior to Fickian diffusion models. A thermal death model which predicts the probability of damage to involuntary transient migrants through a spreading plume is described. Test results show good capability to the extent that human sensory system can detect incipient damage to fish. Actual river temperature data from the Hanford nuclear production plants are used as a basis for the modeling. (13 references) (auth)

46284 EFFECT OF REACTIVITY FEEDBACK ON REACTIVITY ACCIDENTS IN LIGHT WATER POWER REACTOR. Ishikawa, Michio (Japan Atomic Energy Research Inst., Tokyo); Kuge, Yasushi; Kambayashi, Yuichiro; Takeuchi, Eiji; Ohnishi, Nobuaki. Nippon Genshiryoku Gakkaishi; 13: No. 6, 318-29 (Jun 1971). (In Japanese).

Reactivity feedback effects by moderator temperature coefficient and void coefficient were believed to have less importance in controlling a fast power excursion, such as a reactivity accident in a light water power reactor, since they are mainly caused by heat transfer from fuel to coolant occurring after considerable time delay. Recent SPERT-III E-core transient tests, however, have revealed that moderator feedback effects compensate significantly the magnitude of reactivity, under reactor conditions of high temperature or high power level, and that this moderator feedback is generated by prompt neutron slowing down energy. The SPERT experiments were analyzed by the multi-channel nuclear thermal hydrodynamic kinetics code, EUREKA, with the view to examining the moderator feedback effect. As a result, the SPERT conclusion mentioned above was confirmed. The influence of differences in reactor system temperature, initial power level, coolant velocity, reactor period, and moderator temperature coefficient on the moderator feedback reactivity effect was examined through comparisons with the SPERT experiments. It was concluded that safety analyses on reactivity accidents in light water power reactors would involve a significant amount of error if moderator feedback effect is ignored. (auth)

46285 PROTECTION AGAINST LOCAL CORE ACCIDENTS IN LIQUID METAL FAST BREEDER REACTORS. van Erp, J. B.; MacFarlane, D. R.; Fauske, H. K. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 15: No. 4, 441-57(May 1971).

An analysis is presented concerning the performance characteristics of sensors considered for use in protection systems of liquid metal fast breeder reactors. Alternate solutions to protection systems having one or more reactor-trip channels per fuel subassembly are proposed. Primary emphasis is placed on pressure pulse sensors, installed in the upper (and possibly also lower) coolant plenum, capable of sensing the collapse of sodium vapor bubbles. It is shown that, even for the limit-case of a complete coolant blockage of one or more fuel subassemblies, a reactor protection system based on pressure pulse sensors should be capable of effecting reactor-shutdown prior to generation of any substantial amount of molten fuel. Some preliminary experimental data regarding vapor bubble collapse are presented, showing reasonable agreement with analytical predictions. 18 references. (auth)

Power Conversion Systems

46286 (CONF-710315-24) 1000 Mwe LMFBR STEAM GENERATOR. Muenchow, H. O. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.); Armstrong, R. C. (Combustion Engineering, Inc., Chattanooga, Tenn. Nuclear Components Dept.). 1971. Contract AT(30-1)-4004. 6p. Dep. NTIS.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

A bayonet-tube, split-bundle-design, sodium-heated steam generator is being developed for a 1000-MW(e) LMFBR power plant. It can operate as a once-through unit at full loads and as a recirculating unit at partial loads. For 950°F outlet steam temperature, presently available materials can be used to fabricate a competitively priced unit for near-term plants. Advantages are shown in ease of fabrication, maintenance, and operation. (auth)

46287 (EUR–4336) DESIGN OF THE STEAM GENERATORS FOR THE 300 MW THTR PROJECT. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 26p. (In German). NTIS (U. S. Sales Only).

The steam generators for the 300 MW THTR reactor are noused in the prestressed concrete pressure vessel, together with the core and the gas circulators. This arrangement lays a number of special requirements on steam generator design. The generators are intended to be removable, yet to require no routine inspection. They must have a small outside diameter yet cause a low gas pressure drop. For a given diameter the length of the steam generator is determined by the required volume. The units must be securely mounted. Main-steam and reheater temperatures are to be controlled by spraying. The number of penetrations in the reactor vessel membrane must be as low as is compatible with steam generator safety. The stringent safety requirements make precise knowledge of part-load behavior desirable. Compact construction must be reconciled with ease of construction and testing, and with safe design. The approach that followed in order to meet the mutually contradictory requirements is discussed. (EURATOM

Research and Test Reactors

Refer also to abstracts 44583 and 44655.

46288 (AECL–3854) SAFE DRY TIMES FOR IRRADIATED NRU FUEL ASSEMBLIES. Downie, C. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1971. 25p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

A description is given of a method used to predict the temperature transient which would be experienced by an irradiated fuel assembly if it remained in a dry environment for an extended period. The method was applied to the standard type of fuel assembly irradiated in the NRU Reactor. "Safe Dry Times" were evaluated at heat ratings which occur during the normal fuel discharge. The heat transfer model assumed a gray enclosure containing 33 interreflecting surfaces. The radiation absorption factors between the concomitant zones were derived using Gebhart's method. Integration of the differential equations describing the heat flow for each zone was performed using the DEEMS subroutine. 4 references. (auth)

46289 (EUR–4462) SAMPLED TRANSFER FUNCTION OF A PULSED FAST REACTOR. Arhan, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 36p. (In French). NTIS (U. S. Sales Only).

The principles of pulsed fast reactors are explained and reference is made to the SORA reactor. Then the essential results of one-group discrete-time kinetics for such reactors are established: the theory leads to a set of recurrent equations for kinetics. It is shown that the set of differential equations for the thermal description of the reactor may be converted into discrete-time equations. These two results, properly z-transformed, lead to the sampled transfer function for the whole reactor. The theoretical results are numerically applied to the pulsed fast reactor SORA. (EURATOM)

46290 (GEAP–10010-28) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Twenty-Eighth Quarterly Report, February–April 1971. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). May 1971. Contract AT(04-3)-540. 87p. Dep. NTIS.

BORON CARBIDES—design parameters of control rods of B_4C, for use in liquid sodium
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, design parameters of fuel rods of, with built-in instrumentation
REACTOR CONTROL ELEMENTS—design parameters of boron carbide (B_4C) rod type, for liquid sodium coolant fast test reactor
—design parameters of instrumented plutonium oxide (PuO_2)–uranium oxide (UO_2) rod type, for liquid sodium cooled fast test reactor
REMOTE-HANDLING EQUIPMENT—design parameters of emergency retrieval, for liquid sodium cooled fast reactor fuel handling equipment
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—operations during February to April 1971
—maintenance during February to April 1971
—control rods for, design parameters of FRED tests
—fuel element assemblies for, design parameters of Core 2 instrumented plutonium oxide (PuO_2)–uranium oxide (UO_2)
—reactivity measurements for plutonium oxide (PuO_2)–uranium oxide (UO_2) fueled, 0 to 20 MW
—startup testing of plutonium oxide (PuO_2)–uranium oxide (UO_2) fueled
—core vessel for, stress analysis for head bolts of
—fuel handling systems for, design parameters of emergency retrieval equipment for
URANIUM OXIDES UO_2—PuO_2–UO_2, design parameters of fuel rods of, with built-in instrumentation (D.C.C.)

46291 (GEAP-13702) SEFOR CORE I TEST RESULTS TO 20 MW. Noble, L. D.; Raberain, A. M.; Pflasterer, G. R.; (and others) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr 1971. Contract AT(04-3)-540. 250p. Dep. NTIS.

The Southwest Experimental Fast Oxide Reactor (SEFOR) is a fast spectrum reactor fueled with mixed PuO_2–UO_2 and cooled with sodium. The reactor was designed to enable the determination of the Doppler coefficient at fuel temperatures up to the vicinity of fuel melting, and an experimental program was planned for Core I that begins with a series of tests at low power, proceeds through static and oscillator tests at various power levels up to full power (20 MW), and culminates in a series of subprompt and super-prompt critical transients. The results of static and oscillator tests performed at power levels up to 20 MW and at fuel temperatures up to approximately 4800°F during the power ascension phase of the experimental program in SEFOR Core I are reported. The experimental results are in agreement with calculations at all power levels, and preliminary analysis of data indicates that the SEFOR Doppler coefficient T(dk/dT) is -0.0081 ± 0.0014 (estimated standard deviation). This coefficient compares favorably with the value of -0.0085 that was predicted prior to the experiments. (46 references) (auth)

46292 (INR-1288) PHYSICAL AND GEOMETRICAL PARAMETERS OF ANNA CRITICAL ASSEMBLIES. PART I. Dabrowski, Cyryl; Malewski, Stefan (Institute of Nuclear Research, Warsaw (Poland)). 1971. 32p. Dep. NTIS (U. S. Sales Only).

Several critical ANNA assemblies have been analyzed with the aim to determine their physical parameters from the calculation of the fine structure flux distributions in the elementary cells and of the slowing-down and resonance effects. These parameters have been used to determine the critical sizes and neutron density distributions in two-group diffusion approximation. A comparison of the calculated data with the available experimental results has been carried out. 13 references. (auth)

46293 (JUL-717-RX) INFLUENCE OF NUCLEAR HEATING ON THE FORMATION OF TEMPERATURE FIELDS AND THE THERMAL BEHAVIOR OF NUCLEAR REACTOR SLIDE-IN UNITS. Stelzer, Friedrich (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Dec 1970. 106p. (In German). Dep. NTIS (U. S. Sales Only).

The temperature fields in reactor probe units deviate from the usual temperature fields because of the internal heat release. The processes leading to the heat release are described. Methods are given for the calculation and measurement of the heat release. Mathematical methods are developed for description of the reactor-specific temperature fields. Three groups of problems are considered. The direct problem is one in which the mathematical model exists and the temperature field is unknown. The inverse problem is one in which the mathematical model and potential field are known but the equation coefficients are unknown. The determination of the specific heat conductivity from the temperature measured values of a device is treated as an example of the indirect problems. Inductive problems are those in which the mathematical model must be developed for a given potential field. A calculation method is developed which makes possible an accurate design of high temperature radiation devices with respect to the temperature by use of the analogy to Ohm's law. It is shown how nuclear heating of a fluid can be used for the operation of a circuit, as for the Jülich cold neutron source. A differential equation for the evaporation process of a reactor liquid is established. 29 references. (tr-auth)

46294 (KURRI-TR-75) REPORTS OF THE STUDY MEETING ON COMPUTER CONTROL OF NUCLEAR REACTOR. Keiji, Kanda; Shigenori, Fujine; Masatoshi, Hayashi (eds.) (Kyoto Univ. (Japan). Research Reactor Inst.). 16 Feb 1970. 116p. (In Japanese). (CONF-700225). Dep. NTIS (U. S. Sales Only).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Included are 17 papers on the application and performance of computers for reactor control and data processing. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 46154, 46242–46248, 46280, and 46295–46302.

46295 (KURRI-TR-75, pp 20-3) DATA PROCESSING SYSTEM IN FCA. Koyama, Kinji (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The computer system (MPDA-9) installed in the Fast Critical Assembly (FCA) is not for controlling the reactor, but to obtain the results of various experiments and analyses more accurately and faster. The specifications of the computer system in the FCA are determined by the conditions of accuracy, and obtained data are written in the form capable of being read directly with large-sized computers. A method of analysis for the measurement of the reactivity characteristics of control rods is reported as an example of the problems requiring much calculation, for which the MPDA-9 system is applicable. (Japan)

46296 (KURRI-TR-75, pp 24-9) COMPUTER CONTROL IN JMTR. Tanaka, Toshiyuki (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The Japan Material Testing Reactor (JMTR) was constructed for the purpose of irradiation testing the fuels and materials used in the atomic energy industry. To satisfy the operating requirements, a data processing system and a medium-sized computer were introduced. The necessity of technical management by using the computer on-line is indicated on problems such as output calibration, the method of holding the power, and the calculation of reactivity balance. (Japan)

46297 (KURRI-TR-75, pp 30-3) OPERATION OF TTR WITH A DIGITAL COMPUTER. Takamatsu, Shigeyuki (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Toshiba Training Reactor (TTR) is a swimming pool type research reactor of 100 KW. The computer control system for automating start-up and shutdown procedures is described. The system including the TOSBAC-3225A computer was first operated experimentally in 1965, and has been improved for use in daily operation. The details of specifications and the check-up prior to operation are reported briefly. The system is also applied to experiments for optimization of control and reactivity balance. (Japan)

46298 (KURRI-TR-75, pp 34-9) DIGITAL COMPUTER CONTROL OF HTR. Miyagaki, Hisanori; Takumi, Kenji; Taguchi, Toyohira (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

It is very important to establish the experimental analyzing method for dynamic systems and to develop a computer control system for nuclear power plants. As one attempt for these purposes, the computer control experiment for a research reactor was planned, and complete automated operation was practiced in Hitachi Training Reactor (HTR), the swimming pool type research reactor of 100 kW. The items of automation in the HTR were as follows: (1) start-up control; (2) power level variation control; (3) constant power control; (4) shut down control; and (5) failure detection and alarm for the system. As a central processing unit, the transistorized digital control computer HITAC 501 A is used, the memory of which is a 2K word drum with twenty skip switches for external break-in. Data obtained when the power

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is increased from the shut down state of 30mW up to the set level of 2kW, are shown in figures. In this example, by changing the control mode when the power level was increased to 50% of the set value, excellent results were obtained, in which the output overshoot was less than 1% after the set value was reached. (Japan)

46299 (KURRI-TR-75, pp 40-6) ELECTRONIC COMPUTER SYSTEM IN DCA. Shiba, Kiminori (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Deuteron Critical Assembly (DCA) was built for the purpose of developing a heavy water moderated boiling light water reactor. Since measured values of high accuracy are frequently required the system including TOSBAC-3400 model 31 computer is installed to collect the data efficiently and analyze them rapidly. On designing the computer system, there are five fundamental requirements. The computer was required to have the following function to satisfy these requirements. (1) To be able to compile the language of FORTRAN-IV or equivalent. (2) To have high speed data transmission circuits. (3) To be possible to perform ADD-1 processing at high speed. (4) To be equipped with analog and digital input devices. One of the major advantages of this system is to be equipped with direct access control system (DAC), through which data writing into, and reading from the core can be performed in a time nearly equal to core access time. (Japan)

46300 (KURRI-TR-75, pp 99-104) COMPUTER CONTROL OF KUR-2. Kanda, Keiji (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The unique feature of KUR-2 (Kyoto University Reactor) is that the core of the reactor has two regions, and a thermal peaking region is located between them. By installing the thermal peaking region, neutron flux density higher than that of a normal reactor with output power rating of 30 MW can be obtained. As the output power is increased, computer control of KUR-2 is considered mandatory in the following problems: (1) constant thermal output control; (2) uniform neutron flux distribution; (3) constant neutron flux or spectrum control within the thermal peaking region; (4) Xe oscillation; (5) uniform burnup control; (6) operational pattern selection; and (7) determination of refueling methods or procedures. (Japan)

46301 (KURRI-TR-75, pp 105-7) COMMENT ON COMPUTER CONTROL OF KUR-2, (1). Monta, Kazuo (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

Some comments are given on the possibility of computer control of the KUR-2 reactor. The items examined are: (1) constant thermal output control; (2) flux and spectrum control in thermal flux peaking region; (3) prevention of Xe oscillation; (4) uniform burnup control; (5) operational pattern selection; and (6) refueling methods and procedures. (Japan)

46302 (KURRI-TR-75, pp 108-10) COMMENT ON COMPUTER CONTROL OF KUR-2, (2). Serizawa, Michiya (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on computer control of nuclear reactor; Osaka, Japan (16 Feb 1970).

The possibility of computer application to the items examined by the committee of KUR-2 and the methods of simulation to develop the computer control system are described. Comments on the possibility of computer control application are as follows: (1) Constant thermal output control will be attained without difficulty, because many test examples have already been given. (2) Constant spectrum control within thermal flux peaking region is best performed by controlling the structure of moderator in the region. (3) Xe oscillation will not occur if the core of KUR-2 has the same size as that of JMTR (30 MW). (4) Uniform burnup seems to be impossible in such a small reactor as the KUR-2. The control algorithm must completely be checked for digital control of the KUR-2, and it is desired to depend upon simulation to develop the new control algorithm in view of safety. Uses of a hybrid computer system and a digital computer system are illustrated as examples of simulation to design the new control system, to evaluate program running time, or to check operating conditions of the system. (Japan)

46303 (LA-4723) PROPOSAL FOR AN INTENSE STEADY-STATE NEUTRON SOURCE. King, L. D. P. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 9p. Dep. NTIS.

The Kinetic Intense Neutron Generator (KING) reactor is an advanced concept which promises to provide a substantial breakthrough in existing steady-state neutron fluxes. The use of a rapidly moving aqueous liquid fuel core removes present steady-state reactor flux limitations since no internal heat exchanger is required. The wide range in uranium fuel concentrations which are permissible in such a system enables one for the first time to optimize both the annular fuel region and control flux trap to give the highest performance index or ratio of thermal flux to reactor power. A conservative 25-MW power level is proposed for the reactor. Thermal neutron flux levels are estimated to be second to none at this power level. The full flux potential for this concept is not known. A 25-MW reactor can serve as a test bed for further studies in which fuel velocities and core transit temperature rise are increased for short times. A description of the KING reactor concept and its dynamic test is presented. 28 references. (auth)

46304 NUCLEAR REACTOR RESEARCH AT QUEEN MARY COLLEGE. Shaw, J. (Queen Mary Coll., London). J. Inst. Nucl. Eng.; 12: No. 3, 71-4; 79-81(May-Jun 1971).

A nuclear reactor, providing a low energy critical facility with a neutron flux of $10^8 n/cm^2/sec$ and a large region of uniform flux is described. The pertinent advantages of limiting the flux are noted and reasons for the choice of manufacturer given. Difficulties with the purchase of certain parts, especially the fuel elements, are outlined and the type and dimensions of the elements given. Criticality was achieved on October 10, 1964 with a critical size of 3212 gm ^{235}U. The purchase of a reactor site in London and regulations covering population distribution near the site are described. Installation and commission were completed in September 1967. The heat exchange system, necessary when the reactor went to its peak power of 100 kW in November 1970, is detailed. The reactor core and available facilities are described and the experiments carried out as a basis of teaching listed. (UK)

46305 SOME ANOMALIES IN THE OPERATION OF POLYMERIZED KY-2 AND AB-17 ION-EXCHANGERS IN THEIR USE FOR WATER DESALINATION OF THE FIRST COOLING CIRCUIT OF THE IRT TYPE NUCLEAR REACTOR. Kolomiitsev, M. S.; Episheva, S. M.; Danilova, O. A.; Charbadze, L. A. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 62: No. 3, 549-52(Jun 1971). (In Russian).

Anomalous behavior of ion exchange resins of the KY-2 and AB-17 types was detected during water purification of a nuclear reactor, consisting in the loss of the exchange capacity when there occurs a slight lowering in the ion-exchanger capacity. A model is suggested to explain the anomaly. Mechanical destruction of resins, removal of particles from the filters, and their radiolysis during passage through the core with the subsequent absorption of fragments on the resin of the opposite type are considered to be the causes. (auth)

46306 INVESTIGATION OF A HYDROGEN-FREE SHIELD FOR HEAVY-WATER POWER REACTORS. Holman, Miloslav; (Construction Engineering for Nuclear Electricity, Plzen, Czech.); Kovarik, Karel; Marik, Petr; (and others). Jad. Energ.; 17: No. 4, 109-13(Apr 1971). (In Czech).

A test of a mock-up is described for a biological shield of the heavy water power reactor BR-5 in the USSR. The cylindrical mock-up was assembled from layers of graphite and steel which were perforated by cylindrical canals of various diameters. This assembly permitted test operation with different layers of materials, canal diameters, and diverse slits for ascertaining their effectiveness as reactor shielding. (tr-auth)

46307 ORGANIC COOLED NUCLEAR REACTOR AND ITS ENVIRONMENT. Weeks, John L. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Arch. Environ. Health; 23: No. 2, 123-8(Aug 1971).

The operation of a nuclear reactor imposes certain stresses upon an environment as a whole, and upon the working environment in particular. Such stresses have been studied for many types of reactor, but the organic cooled reactor has received little public attention. The reliability of this reactor system has been demonstrated during a $5\frac{1}{2}$-year operating period. Experience gained during this period in relation to radiation exposure, safety, toxicity of the coolant, and the effects of the reactor upon the environment is considered. The exposure of reactor operators to ionizing radiation has been only slightly in excess of the level permitted for the general public. There have been no explosions or serious fires. No harmful effects of the coolant have been demonstrated either in exposed personnel or in the surrounding environment. 15 references. (auth)

Rocket and Space Reactors

46308 (GULF-RT-10577) DEVELOPMENT AND VERIFICATION OF DESIGN METHODS FOR DUCTS IN A SPACE NU-

CLEAR SHIELD. PHASES 4 AND 5. Final Report. Cerbone, R. J.; Read, P. A. (Gulf Radiation Technology, San Diego, Calif.). 31 Mar 1971. Contract AT(04-3)-167. 144p. Dep. NTIS.

In the reference NERVA reactor, a light-weight shield, made of neutron and gamma attenuating material, is located above the reactor core support plate as a central shield and above the reflector as an extension shield. The material is composed of boron carbide, aluminum, and titanium hydride (BATH). Approximately 6000 small diameter (<0.2 inch) coolant holes in line with the core penetrate the shield. Thirty piping penetrations (~1 inch diameter) are located in the peripheral shield through which hydrogen flows to the support plate system. A study to measure and calculate neutron streaming with the holes penetrating the peripheral shield is described. The study included: (1) Development of the DUCT code to include the treatment of multiple ducts, a DASH flux input option, and the use of coupled neutron gamma ray transfer cross sections. (2) Extend an experimental-analytical comparison to include neutron and secondary gamma production and transport in a NERVA-BATH shield assembly. 11 references. (H.D.R.)

46309 (N-71-12568) MALFUNCTION ANALYSIS OF A CONCEPTUAL SPACE POWER FAST-SPECTRUM REACTOR. Peoples, John A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1970. 29p. (NASA-TM-X-2057; E-5690). NTIS.

Four types of reactor malfunctions were examined: (1) control drum run-in, (2) reduction of coolant flow, (3) reduction of coolant inlet temperature, and (4) complete loss of coolant. The results show that this reactor concept exhibited an inherent safety factor due to its relatively slow response to each of these malfunctions. With the reactor at cold critical, reactivity insertions should be limited to a safe margin below 9.7 cents per second to avoid a prompt critical condition. Normal coolant velocity per channel (3.95 ft/sec or 1.20 m/sec) can be reduced to almost 10 percent of design before fuel temperatures approach 2500°R (1389°K). A step decrease of 210°R (117°K) in the normal coolant inlet temperature (2100°R or 1667°K) still provides a safety margin of almost 40 sec before fuel temperatures reach 2500°R (1389°K). Six sec are required following a complete loss of coolant accident for fuel temperatures to reach 2500°R (1389°K). (auth) (STAR)

46310 (N-71-15162) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 1. SYNOPSIS OF METHODS AND RESULTS OF ANALYSIS. Final Progress Report. Soltesz, R. G.; Disney, R. K.; Kaiser, R. S.; Jedruch, J.; Zeigler, S. L. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 98p. (NASA-CR-102964; WANL-PR-(LL)-34(Vol.1)). NTIS.

The material presented includes the following sections: (1) use of the MSFC complete code package with descriptions of the preliminary or parametric design method and the detailed design method; (2) nuclear shielding methods and master library data with descriptions of the computer codes and master library files; and (3) evaluation and calculations with a presentation of selected results using the code package. (auth) (STAR)

46311 (N-71-15840) EXPERIMENTAL INVESTIGATION OF CONDENSER PRESSURE CONTROL DURING SNAP-8 STARTUP. 2. DEADBAND FLOW CONTROL OF CONDENSING PRESSURE. Fisher, Roland C.; Tew, Roy C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1971. 40p. (NASA-TM-X-2115; E-5730). NTIS.

A critical area of concern in the startup of the SNAP-8 system to the self-sustaining level is the controllability of the condenser inlet static pressure. A deadband condenser inlet pressure control method was applied to a SNAP-8 system in a ground test facility. This control method, wherein condenser inlet pressure excursions outside the deadband limits resulted in ramp changes in flow of the condenser coolant, was used successfully during a large number of start tests of the system. Parameters that could be manipulated in optimizing this control method were investigated. The influence of outside disturbances on operation of the control was also noted. (auth) (STAR)

46312 (N-71-17369) PRESTARTUP THAWING OF LITHIUM COOLANT IN A NUCLEAR REACTOR FOR A SPACE POWER PLANT. Lustig, Paul H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1971. 29p. (NASA-TM-X-2177; E-5771). NTIS.

A calculational study was made assuming heated argon gas being pumped through an annular space between the reactor primary loop and a surrounding jacket. Pumping power requirements and time to melt as a function of radial and axial temperature differences were plotted. Heating power and energy requirements were also determined. The lithium in the reactor could be completely melted in less than 24 hours without exceeding a temperature difference of 25°R (13.9°K) radially or 30°R (16.6°K) axially or a pumping power of 1 kilowatt. An annular gap of ¼ inch (0.635 cm) was needed and the initial reactor temperature was greater than 200°R (111°K). Constant-heat-flux and constant-inlet-temperature modes of heating were studied, the latter of which can reduce the time to melt by a factor of 4 and the energy requirement by a factor of 2.5. The heating power was 27.5 kilowatts initially for a constant-inlet-temperature mode compared to less than 1 kilowatt of pumping power. Therefore, the heating mode may be dictated by the availability of auxiliary power. (auth) (STAR)

46313 (N-71-17422) NEUTRONIC DESIGN FOR A LITHIUM-COOLED REACTOR FOR SPACE APPLICATIONS. Whitmarsh, Charles L. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1971. 40p. (NASA-TN-D-6169; E-5775). NTIS.

Performance goals were 2.17 MW(t) for 50,000 hours with a coolant outlet temperature of 1222°K. The reactor was fueled with enriched UN and controlled by rotation of six fueled drums. The fuel was zoned radially to reduce local power peaking and to enhance reactivity worth of the control system. Local power in the core was limited by a 1% creep criterion established for the fuel cladding. Total control swing was 8.51% Delta k/k. Power distributions, core characteristics, and accident effects are calculated. (auth) (STAR)

46314 (N-71-18866) OPERATING CHARACTERISTICS OF THE PRIMARY FLOW LOOP OF A CONCEPTUAL NUCLEAR BRAYTON SPACE POWER PLANT. Turney, George E.; Kieffer, Arthur W.; Petrik, Edward J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1971. 37p. (NASA-TM-X-2161). NTIS.

An analytical study was made of the steady-state and transient operating characteristics of the lithium cooled primary flow loop of a conceptual nuclear Brayton space powerplant. From the system investigation, it was determined that (1) the steady-state power of the reactor varies linearly with (a) the inserted reactivity and (b) the flow rate of inert gas in the Brayton power conversion loop (2) the flow rate of lithium in the primary loop has a small effect on the reactor steady-state power. The transient changes in the reactor power and temperature of the primary loop were determined for step input disturbances in (1) inserted reactivity, (2) lithium flow rate in the primary loop, and (3) inert-gas flow rate in the Brayton power conversion loop. The response of the system to these step changes can be characterized as stable and highly damped. (auth) (STAR)

46315 (N-71-19875) CABLING AND CONNECTORS FOR USE ON A NUCLEAR STAGE. Final Report. Abrams, G. I. (McDonnell Douglas Astronautics Co.-West, Huntington Beach, Calif.). 23 Feb 1971. Contract NAS8-25620. 178p. (NASA-CR-103056; MDC G-757). NTIS.

The cable and connector data relevant to a reusable nuclear shuttle are detailed and appropriate recommendations are made. The environmental and functional requirements are defined, and radiation effects on organic and inorganic materials are presented. Attractive insulation materials and fabrication techniques for the steady-state radiation environment are coupled with candidate system concepts including flat, round, and ribbon cable approaches. Aluminum, permanent, connectorless, and conventional terminations are considered. Recommendations include the use of copper conductors, all-polyimide insulation, small gage, flat conductor cable for major wire bundles, conventional round wire for power and short point-to-point installations, and extensive use of permanent and connectorless terminations to enhance reliability. (auth) (STAR)

46316 (N-71-20155) SHUTDOWN CHARACTERISTICS OF A SNAP-8 POWER CONVERSION SYSTEM. Hecker, Thomas P.; Boecker, Fred; Frye, Robert J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1971. 22p. (NASA-TN-D-6172; E-5993). NTIS.

An experimental study of the shutdown of a SNAP-8 mercury Rankine power conversion system was conducted to determine the system response to both normal and emergency shutdown procedures. A failure of the condenser coolant flow was the simulated system condition for the emergency shutdown procedure. The results of both shutdown procedures show that the system can be repeatably shut down in such a way as to ensure its restart capability. Transient data for three typical shutdowns are presented. (auth)

46317 (N-71-20295) STATUS OF OPEN-CYCLE GAS-CORE REACTOR PROJECT THROUGH 1970. Ragsdale, Robert G. (National Aeronautics and Space Administration, Cleveland, Ohio.

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Lewis Research Center). Mar 1971. 23p. (NASA-TM-X-2259; E-5608). NTIS.

Some recent gas-core reactor research experiments are reviewed, and engine performance characteristics are estimated using these latest results. Flow experiments using air/air indicate the uranium consumption might be less than 1% of the hydrogen propellant requirement. Specific impulses as high as 7000 seconds may be possible at rocket vehicle accelerations of 0.01. Additional work is required to more realistically simulate engine conditions in laboratory experiments. (auth) (STAR)

46318 PROSPECT OF SPACE PROPULSION IN THE NEXT DECADE. Coghe, Aldo (Politecnico, Milan); De Luca, Luigi; Giaccio, Mario. Termotecnica (Milan); 25: No. 5, 233-48(May 1971). (In Italian).

The principles of the different systems of rocket propulsion are described. The present status of each of these systems is presented in certain detail and developments in the near future are predicted. The argument is treated from a technical and economic point of view, emphasizing particularly those problems which seem to be the most important in the future development of rocket propulsion, at least in the next decade. 16 references. (auth)

46319 RADIOISOTOPIC AND REACTOR THERMOELECTRIC CONVERTERS OF ENERGY. Pushkarskii, A. S. (State Committee for the Utilization of Atomic Energy, Moscow); Okhotin, A. S. At. Energy Rev.; 9: No. 2, 251-346(Jun 1971).

Various aspects of the problem of the thermoelectric conversion of thermal energy into electricity are reviewed. The physico-energetic basis of thermoelectricity and the stage reached in the physics of the thermoelectric process are considered, the main thermoelectric semiconductor materials are described, and the methods used for calculating thermoelectric devices are shown. Descriptions are given of various types of reactor and radioisotopic thermoelectric generators, and the designs, applications, merits and demerits of the systems considered are analyzed. 186 references. (auth)

Process Heat and Desalination Reactors

46320 OPPORTUNITIES FOR AUGMENTING WATER SUPPLIES THROUGH DESALTING. O'Brien, James J. (Dept. of the Interior, Washington, D. C.). Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 196-201(1971).

Promising opportunities for desalting are discussed in the light of projected national and regional water supplies and in relation to alternatives. The legal, political, institutional, and environmental factors influencing the choice of desalting and economic considerations in evaluating desalting as an alternative are examined. (auth)

46321 PUERTO RICO ENERGY CENTER: DESALTING ASPECTS. Fragoso, J. Hernandez; Byrnes, James J. (Burns and Roe, Inc., Hempstead, N. Y.). Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 217-23(1971).

The main concepts considered and the preliminary findings of a feasibility study of a nuclear energy center for the coastal regions of Puerto Rico are presented. Costs are compared for several types of desalting plants. The economics of recovering salt and chemicals from the brine waste of the desalting plant are examined. (H.D.R.)

46322 PRINCIPAL FACTORS RELATING TO THE SELECTION OF SINGLE-PURPOSE AND DUAL-PURPOSE DESALTING PLANTS. Homer, William A.; Scharpf, Carl A. (Bechtel Corp., Los Angeles). Chem. Eng. Progr., Sym. Ser.; 67: No. 107, 184-95(1971).

Some of the principal factors that must be considered in the planning and design of single- and dual-purpose power and desalting plants are discussed. Emphasis is placed on the nuclear power and flash distillation combination since this concept has been extensively studied. Some of the factors discussed are based on studies and evaluations conducted in connection with the Bolsa Island nuclear power and desalting project. After a brief review of the principal desalting processes, the economic features and other factors that most frequently form bases for selection of the preferred concept are discussed. (auth)

46323 USE OF NUCLEAR ENERGY IN DESALINATION PLANTS. Baranowski, K. Tech. Mitt. Krupp, Werksber.; 28: No. 2, 41-8(Jul 1970). (In German).

The use of desalination plant in combination with different types of nuclear reactors built or planned in West Germany is investigated and the different combinations are compared. (auth)

Marine and Portable Power Reactors

46324 (AD-717561) SM-1A CORE IV DESIGN ANALYSIS. Final Report. Iyer, Shrinivas S.; Langley, J. Randolph; Saunders, R. Stuart; Neuman, Richard R. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). 1 Jun 1970. 160p. (ED-7006). NTIS.

A detailed discussion of the analytical technique used for the SM-1A core 4 design studies is given. Background information of core 4 is given, followed by a summary of the results obtained. The nuclear analysis, steady-state thermal-hydraulic behavior and transients accompanying certain types of accident situations are presented in subsequent chapters. (auth) (USGRDR)

46325 (EUR-4356) NERO DEVELOPMENT PROGRAMME. Final Report. Part II (Vol. III and IV). (Reactor Centrum Nederland, [Petten]). 1970. 442p. NTIS (U. S. Sales Only).

A series of detailed accounts of the experimental work carried out to support the development of a design for an advanced PWR for marine propulsion are presented. (EURATOM)

Production Reactors

Refer also to abstract 46178.

Reactor Theory

46326 TEPLOFIZIKA YADERNYKH REAKTOROV S ZHIDKOMETALLICHESKIM OKHLAZHDENIEM I METODY ELEKTROMODELIROVANIYA. (Simulation Methods for Thermal Hydrodynamics of Liquid Metal Cooled Nuclear Reactors). Minashin, V. E.; Sholokhov, A. A.; Gribanov, Yu. I. Moscow; Atomizdat (1971). 312p.

Hydrodynamics and heat exchange are analyzed for liquid metal flow through the active zones of a nuclear reactor. Channels of complex shapes are considered, with both laminar and turbulent flow of coolant. Differential equations of heat exchange are accompanied by methods of their solution. Heat exchange involving assemblies of fuel rods and temperature determination for random changes in heat evolution from a nuclear reactor are considered. Methods of electro-simulation include volume methods, an electrohydrodynamic analogy, electric circuit networks, and circuitry involving cathode-ray tubes. 122 references. (K.S.W.)

46327 RESONANCE INTERACTION EFFECTS. Jawas, G. (Democritus Nuclear Research Centre, Athens). J. Nucl. Energy; 25: 73-83(Feb 1971).

For the calculation of resonance interaction effect a method was used similar to that of Häggblom, [Nucleonika, 12: 97-109(Mar. 1969)] the difference being that instead of rational functions, the exact expression was taken of the function $\Psi(x,\Theta)$ in a series form in ascending powers of Θ and descending powers of $1/1 + x^2$. The resonance interaction effect for the case that the $\Psi(x,\Theta)$ functions can be approximated by the Gauss functions is expressed by the Fermi function. (auth)

Kinetics

Refer also to abstracts 45864, 45876, and 45882.

46328 (BMI-1911) ADEP: ONE- AND TWO-DIMENSIONAL FEW-GROUP KINETICS CODE. Denning, Richard S. (Battelle Memorial Inst., Columbus, Ohio). Jul 1971. Contract W-7405-eng-92. 27p. Dep. NTIS.

The ADEP code solves the few-group, neutron-diffusion equations in time and one or two spatial dimensions. The present version of the code supersedes the more restrictive ADEP-1 and ADEP-2 codes. The numbers of energy groups, delayed precursor groups and mesh points permitted in a calculation are limited by computer storage only. Radial and Cartesian coordinates are allowed. Lumped-parameter, thermal-hydraulic equations are used for the calculation of feedback. 10 references. (auth)

46329 (INR-1276) AN ALGOL PROGRAM FOR COMPUTING GAMMA FLUX DISTRIBUTION IN AND AROUND THE REACTOR

CORE. Pytel, K.; Strupczewski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 22p. Dep. NTIS (U. S. Sales Only).

The Strumgamma program calculates the gamma-heating rate at any point around or in the reactor core by means of the NDA buildup-factor method. The source distribution may be arbitrarily assumed. For the computations of gamma flux distribution in EWA reactor two subprograms have been devised, accounting for horizontal and axial neutron flux distribution and for fuel elements burnup in the reactor. Six gamma energy groups are used. Two regions of various physical properties are considered, but their number may be easily extended. Computations on GIER digital computer are performed at the approximate rate of 100 mesh points per minute, with the computations performed in 6 energy groups for each point.

46330 (LA-4703) DAC2, A TWO-DIMENSIONAL S_n PERTURBATION CODE. Hopkins, G. C. (Los Alamos Scientific Lab., N. Mex.). Jul 1971. Contract W-7405-eng-36. 13p. Dep. NTIS.

DAC2 uses angular fluxes from the 2DF S_n code to calculate reactivity perturbations, effective delayed neutron fractions, and generation times in reactors. In addition to the fluxes, input to DAC2 consists of the input deck to 2DF and the perturbation specifications, each of which is described. (auth)

46331 NEUTRON STREAMING AND ANISOTROPIC EFFECTS IN DIFFUSING MEDIA WITH EMPTY CHANNELS. PART II. Ahmad, Mohammad (Pakistan Atomic Energy Commission, Karachi). Nucleus (Karachi); 7: No. 4, 221-33(Oct 1970).

As a continuation of an earlier article, which dealt with the theoretical aspects of neutron streaming, the present article reviews some of the experimental techniques available for measuring the effect of voids on migration area, diffusion coefficient, reactivity, etc. Also reported are the results of a steady-state neutron streaming experiment on a light-water assembly with a uniform array of empty aluminium tubes. The simple density correction to the neutron diffusion areas to account for the void effects is found to be inadequate. Behrens' theory appears to be the most satisfactory for predicting the radial streaming factors over the whole range of void/material volume ratios investigated and for the axial streaming factors over the largest two void spacings. The agreement between theory and experiment is, however, very poor for the latter case at higher void/material fractions. (auth)

46332 SLOW NEUTRON SCATTERING AND THERMALIZATION WITH REACTOR APPLICATIONS. Parks, D. E.; Beyster, J. R.; Nelkin, M. S.; Wikner, N. F. New York; W. A. Benjamin Inc. (1970). 835p.

The theoretical foundations of the scattering and thermalization of slow neutrons are presented. The theory deals with the modifications of neutron transport theory made necessary by the multivelocity features in the thermal energy region. Selective applications of the theory are described. Comprehensive results for the scattering law and calculated and measured thermal neutron spectra for the most important reactor moderators are presented. Typical reactor applications of the theory are discussed. (H.D.R.)

46333 DECAY OF NEUTRON PULSE IN MULTIPLYING ASSEMBLY USING A SIMPLE KERNEL. Goyal, I. C.; Ghatak, A. K.; Singh, Om Pal (Indian Inst. of Tech., New Delhi). J. Nucl. Energy; 25: 121-8(Mar 1971).

By means of the Laplace transform technique, the time dependent neutron transport equation in a multiplying assembly was solved using a simple scattering-kernel. The complete discrete and continuum solutions were obtained. Numerical calculations were performed for water moderator which gave only one discrete mode. The results were compared with the exact calculations performed using free gas kernel. (auth) (UK)

Dynamics

Refer also to abstracts 44665, 46097, and 46241.

46334 (RT/EL-(69)7, Paper 5) FEASIBILITY OF DIRECT DIGITAL CONTROL FOR AN INTRINSICALLY UNSTABLE NUCLEAR POWER REACTOR. Modonesi, O.; Rimini, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 30p.

From fourth international meeting on electronics and automation; Herceg-Novi, Yugoslavia (13 Jun 1969).

In Italian contributions to the 4th international meeting on electronics and automation.

A pressure-tube nuclear power reactor, moderated by heavy water, cooled by light water, and fuelled by natural U, is described. Due to the neutronic design of the core, the light-water two-phase coolant shows a positive void feedback on reactivity that destabilizes the reactor, while the pressure gives a negative but delayed reactivity contribution. The interplay of these effects determines an intrinsically unstable behavior of the reactor. Stability can be achieved through a proper design of two subloops: the first one for the neutron flux, acting on fast reactivity actuators to keep the neutron power as close as possible to its set point, and the other one for drum pressure, acting on a turbine steam valve. The development of a direct digital control program to achieve these ends is described. (R.W.R.)

46335 MATHEMATICAL METHODS IN NUCLEAR REACTOR DYNAMICS. Akcasu, Ziya; Lellouche, Gerald S.; Shotkin, Louis M. Nuclear Science and Technology. A Series of Monographs and Textbooks. Volume 7. New York; Academic Press Inc. (1971). 469p. $22.00.

Point-reactor kinetics and linear and nonlinear reactor dynamics are investigated. General equations for time-behavior of the neutron population in an arbitrary multiplying medium are described. The methods for reducing these equations to point reactor equations are developed, and solutions of the point-kinetic equations are presented for various reactivity inputs. Feedback effects are described in terms of feedback functionals. Stability criteria are developed and applied to specific reactor models. (H.D.R.)

46336 LINEAR ANALYTICAL MODEL DESCRIBING THE FREQUENCY RESPONSE AND STABILITY BEHAVIOR OF A BOILING LIGHT WATER REACTOR. Hoeld, A. (Technische Univ., Munich). Nucl. Eng. Des.; 16: No. 2, 103-36(1971).

A linear, one-dimensional, one-channel model is presented which gives an analytical description of the frequency response and stability behavior of a boiling light water reactor or loop (both under forced or natural circulation, pressure-controlled or pressure-varying conditions) with respect to perturbations in reactivity (or heating power), primary steam flow (or system pressure), water inlet velocity or subcooling. Based on this model the computer code ADYSMO was established. In order to demonstrate the validity and efficiency of this model, transfer functions measured at different boiling water loops and reactors under different experimental conditions are compared with corresponding ADYSMO calculations. 10 references. (auth)

Experimental Applications

46337 (ANL-7711) SYSTEM ASPECTS AND INTERFACE DATA SETS OF THE ARGONNE REACTOR COMPUTATION (ARC) SYSTEM. Just, L. C.; Henryson II, H.; Kennedy, A. S.; Sparck, S. D.; Toppel, B. J.; Walker, P. M. (Argonne National Lab., Ill.). Apr 1971. Contract W-31-109-eng-38. 301p. Dep. NTIS.

The system subprograms and modules, and a listing of all of the interface data sets of the Argonne Reactor Computation (ARC) System are presented. Programming considerations for use of the ARC System are presented for the methods developer user and the manipulation of user input data is described for the production user. A short historical review is presented relating to the development of the ARC System. (11 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 44376, 44484, 45032, 45043, 45060, 45070, and 45102.

46338 (ANL-7499(Suppl.)) INELASTIC RESPONSE OF PRIMARY REACTOR CONTAINMENT TO HIGH-ENERGY EXCURSIONS. Gvildys, Joseph; Fistedis, Stanley H. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 51p. Dep. NTIS.

The analytical part of the inelastic response of primary containment to high-energy excursions is studied. The computer program and some other analytical considerations, such as a numerical stability criterion, equations of state of mixed materials, and some comparison of the code with experimental results are presented. (auth)

46339 (EUR-4360) IMPACT STRENGTH ON DROPPING OF SPHERICAL FUEL ELEMENTS. Rausch, W. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1970. 40p. (In German). NTIS (U. S. Sales Only).

Results are given on measurements of the maximum effective forces between fuel elements when they collide. These show that the breaking load down to a time of about 10 μsec, as when two

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elements collide, is virtually independent of time. Thus the statically measured breaking load becomes a criterion for impact strength on dropping. It was further shown that the magnitude of the load on collision of two fuel elements was significantly dependent on the type of graphite (differences ranging up to 40%). It therefore appears logical when specifying impact strength on dropping to include among the characteristics a "quality rating" as a quotient derived from breaking load and maximum force on impact in the case of falling from a specified height. The so-called synthetic elements (Nukem variant) appear to be better by a factor of two than hollow sphere elements, because they are less heavily stressed when they encounter a double breaking load on falling than some of the hollow spherical elements tested. A further advantage is that there is no potential weak spot in the form of a plug. (EURATOM)

46340 (EUR–4503) DETERMINATION OF GASES DISSOLVED IN ORGANIC COOLANTS. Colombo, A.; Friessen, R.; Veneroni, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 14p. (In Italian). NTIS (U. S. Sales Only).

A simple system for sampling organic coolants from loops at high temperature and pressure is described. It offers noticeable advantages over the usual technique of sampling by means of a metallic "sampling bomb." A classical apparatus—extraction under vacuum—for the determination of the gases dissolved in the coolants is also described. (EURATOM)

46341 (IN–1467) ANALYTICAL MODEL DESCRIBING THE BEHAVIOR OF FISSION PRODUCTS IN OPERATING FUEL PINS. Yuill, W. A.; Baston, V. F.; McFadden, J. H. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 63p. Dep. NTIS.

An analytical model was developed to describe the release of fission products to the fuel-cladding gap and the distribution of fission products in the fuel during reactor operation. The mathematical model was found to provide an excellent correlation of existing in-pile data for the release of noble gases from uranium dioxide fuel and for the distribution of several fission products in uranium dioxide fuel. The physical model which served as a basis for the mathematical model is described and is found to provide a qualitative explanation for many of the phenomena observed during in-pile studies of the behavior of fission products in operating fuel pins. The important conclusion reached is that the behavior of fission products in the fuel is controlled by a Gibbs-free-energy gradient which is dependent upon both temperature and concentration gradients. Mathematical descriptions must include the effects of both gradients to provide a satisfactory description of the behavior of fission products in operating fuel rods having large thermal gradients. 61 references. (auth)

46342 (N–71–18496) METHODS FOR DETERMINING BURNUP IN ENRICHED ^{235}U FUEL IRRADIATED BY FAST REACTOR NEUTRONS. Richardson, Paul J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1971. 20p. (NASA-TM-X–2153; E–5900). NTIS.

Fission yields of those fission products that vary less than 5% in a thermal or a fast neutron environment are listed. The potential burnup monitors are discussed with respect to their diffusion behavior during high-temperature irradiations, ease of mass spectrometer analysis, and adverse effects of neutron capture reactions. Recommendations are made for the most reliable methods. (auth) (STAR)

46343 ISPOLNITEL'NYE ELEKTRODVIGATELI I ELEMENTY AVTOMATIKI SERVOPRIVODOV YADERNYKH REAKTOROV. (Electric Servomotors and Elements of Servodrives for Nuclear Reactors). Bamdas, A. M.; Leont'ev, A. I.; Titov, E. G.; Yurchenko, A. I. (eds.). Moscow; Atomizdat (1971). 240p.

The subject of special electric motors and automatic servomechanisms for nuclear reactors is examined. A comparison is made of various types of motors for servodrive systems, such as constant current, synchronous, and asynchronous motors. Indicators for position and change of position are described. Much of the book is concerned with sealed step drives, principles, construction, static and dynamic characteristics, gear systems, and traveling disconnects. 128 references. (K.S.W.)

46344 SUB-STOICHIOMETRIC CERAMIC FUELS BY COMPACTION. Pawliw, J. Canadian Patent 871,950. 25 May 1971.

The atomic density and thermal characteristics of fuel for use in a nuclear reactor are improved by the incorporation of U, either natural or enriched, and/or Pu. The sintering of a compacted, cased element may be effected during operation within a reactor. Fertile material such as thorium oxide may also be a constituent of the fuel. (F.S.A.) (Canada)

46345 FUEL ELEMENT SUPPORT GRID FOR NUCLEAR REACTOR. Derussit, R.; Rouge, P.; Thomas, B. (to Commissariat a l'Energie Atomique). Canadian Patent 870,848. 11 May 1971. Priority date 16 Nov 1967, France.

A nuclear fuel assembly is described which consists of canned fuel pencils arranged in parallel and maintained with open-type end support grids which secure the fuel pencils to a protective cylindrical outer sleeve. The assembly is characterized in that the support grids are formed by means of continuous and parallel flat strips disposed in planes tangent to the contour of the fuel pencils in the vicinity of one end. These strips are joined together at the level of each fuel pencil by flat members placed at right angles to the strips. The flat members are pierced by holes and rigidly fixed to the edges of the strips. (F.S.A.) (Canada)

46346 IMPROVEMENTS IN OR RELATING TO EQUIPMENT FOR TESTING FOR NUCLEAR REACTOR FUEL ELEMENT FAILURE. Hackney, Stanley (to United Kingdom Atomic Energy Authority). British Patent 1,237,536. 30 Jun 1971. Filed 14 Aug 1967.

Means are provided for conveying to a common collecting position samples of reactor coolant derived from a particular fuel element or group of fuel elements, together with means at the collecting position for conveying the samples one at a time and sequentially to a conduit having radiation detection means. A second conduit is connected to the collecting position for conveying all the coolant samples, and this is also provided with radiation detection means. The means for conveying the samples to the first conduit preferably includes a fixed annular member having spaced orifices with each of which a coolant sample pipe communicates, and a collecting pipe rotatable about the axis of this member and communicating at one end with the first conduit and at the other end with each of the orifices in turn as the pipe is rotated. The common collecting position preferably comprises a shroud enclosing the annular member, penetrated sealably by the collecting pipe, and connected with the second conduit, whereby coolant samples from all the orifices and from the outlet of the first conduit are collected in the shroud and passed to the second conduit. Either or both of the conduits may be provided with flow couplers so as to induce a satisfactory flow rate in order to keep the total scan time of the equipment within a reasonable limit. A flowmeter may be incorporated in the first conduit to indicate any blockage. The system is claimed to be particularly suitable for liquid metal cooled reactors. (UK)

46347 IMPROVEMENTS RELATING TO FUEL ELEMENT STRINGERS FOR NUCLEAR REACTORS. Bailey, Alan (to Fairey Engineering Ltd.). British Patent 1,238,461. 7 Jul 1971. Filed 1 Jun 1967.

Conventionally, a treaded retaining nut has been screwed onto the lower end of a fuel stringer tie rod for assembly purposes, but difficulty is sometimes experienced in removing such a nut from an irradiated stringer when it is required to dismantle the stringer for the purpose of rearranging the positions of the fuel elements on the tie rod. In the arrangement described, the retaining device comprises an open-ended tubular collet, having two or more longitudinally extending slits, together with a retaining sleeve slidably mounted on the collet, so that when the sleeve is moved into a position surrounding the slitted end of the collet, it presses the latter inwards to engage with external abutments on the end of the tie rod, whereby withdrawal of the collet from the tie rod is prevented. The retaining sleeve may be provided with an internal lip at one end to engage an abutment on the exterior of the collet, to prevent withdrawal of the sleeve over the slitted end of the collet. At the other end the retaining sleeve may be provided with locking tabs. Suitable assembling and dismantling tools are also described, together with methods of assembly and dismantling. (UK)

46348 ENERGY ABSORBING. Eaton, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,236,940. 23 Jun 1971. Filed 6 Feb 1968.

Reference is made to leaf springs used for absorbing the kinetic energy of a body. Conventional leaf springs have a substantially constant load/deflection ratio, so that if impact between body and spring is not to be severe the total deflection in arresting the body must be relatively high. In some circumstances, however, for example where such springs are used in nuclear reactor applications, the body must be arrested with small deflection because of space limitations, but because of the total energy to be absorbed a leaf spring having a high load/deflection ratio is required. In such cases if the body is fragile or has a soft impact surface damage can result. A system is described which overcomes these difficulties. The arrangement is such that the load/deflection ratio is low at the start of the deflection, and therefore provides soft impact, but progressively increases as deflection proceeds. (UK)

GENERAL

46349 (AEC-tr-7125(Vol.1)) COMPUTER ELEMENTS AND SYSTEMS. PROCEEDINGS OF A CONFERENCE IN NOVOSIBIRSK, JUNE 1967. VOL. 1. COMPUTER SYSTEMS. Khoroshevskii, V. G. (ed.). Translation of Vychislitel'nye Sistemy, Izdatel'stvo Nauka Sibirskoe Otdelenie, Novosibirsk, 1968. 175p. (TT-70-50013/1; IPST-Cat.-5707; CONF-670674-(Vol.1)). Dep. NTIS.

46350 (AEC-tr-7125(Vol.2)) COMPUTER ELEMENTS AND SYSTEMS. PROCEEDINGS OF A CONFERENCE IN NOVOSIBIRSK, JUNE 1967. VOL. 2. COMPUTATION AND PROGRAMMING METHODS IN COMPUTER SYSTEMS. Bandman, O. L. (ed.). Translation of Vychislitel'nye Sistemy, Izdatel'stvo Nauka Sibirskoe Otdelenie, Novosibirsk, 1968. 137p. (TT-70-50013/2; IPST-Cat.-5708; CONF-670674-(Vol.2)). Dep. NTIS.

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46352 (ANL-7818) CREATION OF HIERARCHIC TEXT WITH A COMPUTER DISPLAY. Hansen, Wilfred J. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 130p. Dep. NTIS.

46353 (ANL-Trans-896) DISTRIBUTION OF ^{14}C ZYMOSAN IN MICE TISSUE WITH IV INTRODUCTION. Samoilina, N. L. Translated for Argonne National Lab., Ill., from Probl. Gematol. Pereliv. Krovi; 7: No. 6, 16-21(1962). 7p. Dep. NTIS.

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46359 (BNWL-1590) TANDEM METHOD FOR FINDING UNCONSTRAINED MINIMA IN NONLINEAR LEAST-SQUARES PROBLEMS: PROGRAM LEARN-I-C. Kottwitz, D. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1971. Contract AT(45-1)-1830 31p. Dep. NTIS.

46360 CEA-Bib-175) ANNIHILATION OF SLOW POSITRONS IN METALS AND IONIC CRYSTALS. Herve, Alain (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1971. 32p. (In French). Dep. NTIS (U. S. Sales Only).

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46377 (LA-tr-71-54) SHORT-RANGE MOLECULAR INTERACTIONS IN THE SYSTEM $H_2 \ldots H_2$: THEIR DEPENDENCE ON THE ORIENTATION AND INTERNAL GEOMETRY OF THE TWO SPECIES. Tapia, O.; Bessis, G.; Bratoz, S. Translated for Los

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Alamos Scientific Lab., N. Mex., from Int. J. Quant. Chem., Symp.; No. 4, 289-97(1971). 12p. Dep. NTIS.

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Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

Germanic	ä appears as	ae
Germanic	ö	oe
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

XUM

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
  Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
  acetic acid--BF_3, ...
BORON FLUORIDES
  acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
  deposition on nuclear fuel particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
  interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, ΛK(1700) enhancement in, (E)
BARYONS, RESONANCE (N*)
  production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
  binding energy of $\Lambda\Lambda$-He^6, three-body o--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
  predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
  SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

XUM

A

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2262-TA-239	25-45684	Dep. NTIS, 48p.
2785-5	25-44892	Dep. NTIS, 12p.
3086-10 (Vol.2)	25-44801	Dep. NTIS, 73p.
3699-58	25-46386	Dep. NTIS, 8p.
3756-6	25-45030	Dep. NTIS, 59p.
3829-72	25-45797	Dep. NTIS, 31p.
3930-11	25-44728	Dep. NTIS, 129p.
4117-1	25-44489	Dep. NTIS, 27p.
4209-2	25-46387	Dep. NTIS, 14p.
ORNL-		
4666	25-44403	Dep. NTIS, 33p.
4688	25-45443	Dep. NTIS, 142p.
4694	25-45915	Dep. NTIS, 45p.
4708	25-44368	Dep. NTIS, 17p.
4712	25-46388	Dep. NTIS, 90p.
ORNL-HUD-		
9	25-46389	Dep. NTIS, 19p.
ORNL-TM-		
3321	25-45031	Dep. NTIS, 43p.
3348	25-44569	Dep. NTIS, 51p.
3384	25-46268	Dep. NTIS, 30p.
3428	25-46257	Dep. NTIS, 28p.
3433	25-46390	Dep. NTIS, 101p.
3456	25-46276	Dep. NTIS, 75p.
3472	25-45510	Dep. NTIS, 23p.
3480	25-44466	Dep. NTIS, 14p.
ORNL-tr-		
2465	25-45522	Dep. NTIS
2467	25-46391	Dep. NTIS
2473	25-46392	Dep. NTIS
2505	25-46393	Dep. NTIS
2511	25-45115	Dep. NTIS
ORO-		
3065-21	25-45626	Dep. NTIS, 8p.
3091-19	25-46394	Dep. NTIS, 125p.

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Report No.	Abstract No.	Availability
3291-15	25-46395	Dep. NTIS, 14p.
3795-3	25-46396	Dep. NTIS, 52p.
3819-3	25-45487	Dep. NTIS, 39p.
3819-4	25-45488	Dep. NTIS, 30p.
3861-3	25-46397	Dep. NTIS, 14p.
3992-22	25-45779	Dep. NTIS, 35p.
3992-59	25-45685	Dep. NTIS, 52p.
OU-LNS-	(Japanese)	
71-3	25-45707	Dep. NTIS (U. S. Sales Only), 8p.
PA-TR-	(Non-AEC)	
4080	25-45534	See AD-720197
PATENTS	(British)	
1,197,514	25-45021	
1,235,800	25-44490	
1,236,210	25-46165	
1,236,281	25-46160	
1,236,465	25-46162	
1,236,538	25-46161	
1,236,578	25-46163	
1,236,940	25-46348	
1,237,536	25-46346	
1,237,691	25-46159	
1,238,213	25-44670	
1,238,461	25-46347	
1,238,583	25-45842	
1,238,609	25-45325	
1,238,745	25-44589	
1,238,794	25-44708	
1,238,839	25-44590	
1,239,255	25-44591	
PATENTS	(Canadian)	
870,848	25-46345	
870,939	25-44407	
871,950	25-46344	
PATENTS	(French)	
2,001,976	25-44548	
2,002,103	25-45117	
2,031,747	25-44497	
2,038,451	25-44575	
2,038,664	25-44574	
PATENTS	(German)	
1,300,532	25-44418	
PATENTS	(Russian)	
240,884	25-45856	
PATENTS	(U. S.)	
3,577,283	25-45020	
3,580,829	25-44389	
3,585,387	25-44601	
3,585,388	25-44599	
3,586,858	25-44714	
PNE-		
1550	25-44467	Dep. NTIS, 177p.
PNE-G-		
44(Rev.2)	25-44476	See UCRL-50635(Rev.2)
PNE-R-		
49	25-44443	See USGS-474-107
50	25-44444	See USGS-474-108
PPAR-		
24	25-45627	Dep. NTIS, 51p.
PSE-	(Non-AEC)	
101	25-46201	See DOCKET-50282-36
R-	(Misc.)	
86	25-45492	See AD-720773
745	25-45657	See NEVIS-186
RD/B/N-	(British)	
1978	25-44664	Dep. NTIS (U. S. Sales Only), 36p.
RDT-E-		
1-13-T	25-46272	RSO
RDT-F-		
6-10-T	25-45011	RSO
RISO-M-	(Danish)	
1386	25-45838	Dep. NTIS (U. S. Sales Only), 20p.
RLO-		
353-40	25-44964	Radiat. Res.; 46: No. 3, 601-12(Jun 1971)
1388-136	25-45916	Dep. NTIS, 13p.
1388-139	25-46021	Dep. NTIS, 200p.
1725-193	25-44458	Dep. NTIS, 143p.
1725-194	25-44459	Dep. NTIS, 22p.
2225-T-1-8	25-44888	Dep. NTIS, 12p.
2225-T-20-4	25-44545	Dep. NTIS, 5p.
2230-T-2-1	25-46398	Dep. NTIS, 71p.
RPI-	(Misc.)	
3639-15	25-46399	Dep. NTIS, 45p.
RPP/R-	(British)	
8	25-45839	Dep. NTIS (U. S. Sales Only), 9p.
9	25-45840	Dep. NTIS (U. S. Sales Only), 18p.
RT/EL-	(Italian)	
(69)7	25-44665	
SAMSO-TR-	(Non-AEC)	
70-430	25-45238	See AD-716472
70-435	25-45357	See AD-717154
70-437	25-45362	See AD-720243
71-21	25-45360	See AD-718961
71-36	25-45239	See AD-720244
SAN-		
549-7	25-44669	Dep. NTIS, 89p.
595-4	25-44999	Dep. NTIS, 113p.
SC-DC-		
713695	25-44743	Dep. NTIS, 40p.
713706	25-44744	Dep. NTIS, 35p.
713707	25-44745	Dep. NTIS, 38p.
713804	25-44746	Dep. NTIS, 19p.
714161	25-44747	Dep. NTIS, 15p.
SC-DR-		
710169	25-46400	Dep. NTIS, 69p.
710293	25-46401	Dep. NTIS, 27p.
SC-M-		
68-378(Rev. 2)	25-46402	Dep. NTIS, 70p.
70-887	25-46403	Dep. NTIS, 24p.
SC-RR-		
710008	25-46404	Dep. NTIS, 78p.
710089	25-45473	Dep. NTIS, 83p.
710378	25-44748	Dep. NTIS, 39p.
SC-T-		
713044	25-46405	Dep. NTIS
SJC-T-	(Japanese)	
71-2	25-44686	Dep. NTIS (U. S. Sales Only), 17p.
SLAC-Trans-		
132	25-45841	Dep. NTIS
STI/DOC-	(International Atomic Energy Agency)	
10/123	25-44948	IAEA $11.00
STI/PUB-	(International Atomic Energy Agency)	
148	25-44580	UNIPUB, Inc., New York
SU-IPR-		
411	25-45512	Dep. NTIS, 44p.
SWRHL-		
501-r	25-44586	Dep. NTIS, 21p.
502-r	25-44730	Dep. NTIS, 30p.
TID-		
25708	25-44468	Dep. NTIS, 276p.
25711	25-44456	Golden, Colo.; Colorado School of Mines Research Institute (1971). 592p
25715(Vol. 1)	25-44469	Dep. NTIS, 253p.
25715(Vol. 2)	25-44470	Dep. NTIS, 222p.
25715(Vol. 3)	25-44471	Dep. NTIS, 299p.
25715(Vol. 4)	25-44472	Dep. NTIS $5.00, 352p.
25715(Vol. 5)	25-44473	Dep. NTIS, 312p.
25715(Vol. 6)	25-44474	Dep. NTIS, 203p.
25722	25-44475	Dep. NTIS $12.00, 1147p.
25733	25-44454	Dep. NTIS, 54p.
25741	25-45012	Dep. NTIS, 119p.
25743	25-46406	GPO $1.25
25747	25-44317	Dep. NTIS, 158p.
25749	25-44986	Dep. NTIS, 23p.
25756	25-46269	Dep. NTIS, 5p.
25757	25-46270	Dep. NTIS, 3p.
25759	25-44455	Dep. NTIS, 9p.
TLW-	(Misc.)	
1107	25-44335	See CONF-650615-33
TR-	(Misc.)	
5	25-45392	See AD-718415
402-5	25-45470	See AD-719926
TRG-Report-	(British)	

Report No.	Abstract No.	Availability
1943	25-46155	Dep. NTIS (U. S. Sales Only), 19p.
TT-	(Misc.)	
70-50013/1	25-46349	See AEC-tr-7125(Vol.1)
70-50013/2	25-46350	See AEC-tr-7125(Vol.2)
70-50156	25-44991	See AEC-tr-7176
70-55010/4	25-44375	See AEC-tr-7102/4
UAE-NPL-	(Canadian)	
1019	25-45951	Dep. NTIS (U. S. Sales Only), 28p.
UCB-		
34-P-5-59	25-46407	Dep. NTIS, 10p.
UCID-		
30011	25-46408	Dep. NTIS, 20p.
30015	25-46409	Dep. NTIS, 13p.
UCRL-		
13402	25-45072	Dep. NTIS, 67p.
20324	25-46410	Dep. NTIS, 177p.
20472	25-46411	Dep. NTIS, 278p.
20568	25-46412	Dep. NTIS, 117p.
20678	25-45668	Dep. NTIS, 23p.
50635(Rev. 2)	25-44476	Dep. NTIS, 27p.
51033	25-46413	Dep. NTIS, 31p.
51034	25-44477	Dep. NTIS, 54p.
51036	25-46414	Dep. NTIS, 51p.
51044	25-44570	Dep. NTIS, 25p.
51048	25-45539	Dep. NTIS, 20p.
51049	25-44587	Dep. NTIS, 15p.
51057	25-46415	Dep. NTIS, 16p.
51059	25-45495	Dep. NTIS, 116p.
51062	25-44478	Dep. NTIS, 24p.
51066	25-45115	Dep. NTIS, 38p.
51068	25-44479	Dep. NTIS, 20p.
51074	25-44480	Dep. NTIS, 32p.
51082	25-44731	Dep. NTIS, 66p.
73166	25-46416	Dep. NTIS, 16p.
73190	25-44416	Dep. NTIS, 10p.
73254	25-44694	Dep. NTIS, 33p.
UCRL-Trans-		
1437	25-45429	Dep. NTIS
10499	25-46417	Dep. NTIS
UCSD-		
10-P-20-95	25-46418	Dep. NTIS, 111p.
UNC-	(Misc.)	
5252	25-44732	Dep. NTIS, 149p.
UR-		
3999-10	25-44417	Dep. NTIS, 57p.
USGS-		
474-99	25-44442	Dep. NTIS, 55p.
474-107	25-44443	Dep. NTIS, 10p.
474-108	25-44444	Dep. NTIS, 10p.
474-109	25-44462	Dep. NTIS, 27p.
474-113	25-44445	Dep. NTIS, 2p.
474-116	25-44446	Dep. NTIS, 17p.
474-127	25-44447	Dep. NTIS, 29p.
WANL-PR(LL)-	(Non-AEC)	
34(Vol.1)	25-46310	See N-71-15152
WASH-		
1168	25-44571	Dep. NTIS, 151p.
WCAP-	(Misc.)	
7665	25-46273	Dep. NTIS, 276p.
Y-		
1793	25-46419	Dep. NTIS, 25p.
Y-DA-		
4039	25-46420	Dep. NTIS, 13p.
4114	25-46421	Dep. NTIS, 13p.
Y-DD-		
100	25-44572	Dep. NTIS, 13p.
YALE-		
2726-588	25-45869	Particle Accel.; 2: No. 3, 211-25(Jul 1971)
ZJE-	(Czechslovakian)	
100	25-46156	Dep. NTIS (U. S. Sales Only), 20p.

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Appendix I

JOURNAL LIST

This list of journals supplements the listing which appeared as Appendix II in Volume 25, Number 1. The journals are arranged alphabetically by abbreviation.

The title abbreviations are based on the National Clearinghouse for Periodical Title Word Abbreviations, *Word Abbreviation List* published by the Standards Committee Z-39 of the American National Standards Institute.

TID-4579 (5th Ed.) *Serial Titles Cited in Nuclear Science Abstracts* lists the titles and abbreviations of the journals regularly scanned for *NSA* as well as those from which an occasional item is taken. This publication is available from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia, 22151, for $6.00 for full size or reproduction copy and $0.95 for microfiche copy.

A

Acta Agr. Scand.
Acta Agriculturae Scandinavica (Sweden)

Acta Biol. Med. (Gdansk)
Acta Biologica et Medica (Gdansk) (Poland)

Acta Fac. Rerum Natur. Univ. Comenianae, Phys.
Acta Facultatis Rerum Naturalium Universitatis Comenianae, Physica (Czechoslovakia)

Acta Math. (Uppsala)
Acta Mathematica (Uppsala) (Sweden)

Acta Neurol. (Naples)
Acta Neurologica (Naples) (Italy)

Acta Pathol. Microbiol. Scand., Sect. A
Acta Pathologica et Microbiologica Scandinavica, Section A. Pathology (Denmark)

Acta Pathol. Microbiol. Scand., Sect. A, Suppl.
Acta Pathologica et Microbiologica Scandinavica, Section A. Pathology, Supplementum (Formerly Acta Pathologica et Microbiologica Scandinavica, Supplementum) (Denmark)

Acta Pathol. Microbiol. Scand., Sect. B
Acta Pathologica et Microbiologica Scandinavica, Section B. Microbiology and Immunology (Denmark)

Acta Polytech. (Prague), IV
Acta Polytechnica (Prague), Rada IV. Technicko-Teoreticka (Czechoslovakia)

Acta Univ. Upsal., Abstr. Uppsala Diss. Med.
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Medicine (Sweden)

Acta Univ. Wratislaviensis
Acta Universitatis Wratislaviensis (Poland)

Acta Vet. (Brno)
Acta Veterinaria (Brno) (Czechoslovakia)

Actinides Lanthanides Rev.
Actinides and Lanthanides Reviews (Netherlands)
Supersedes Actinides Reviews

Advan. High Temp. Chem.
Advances in High Temperature Chemistry (U.S.)

Advan. Hum. Genet.
Advances in Human Genetics (U. S.)

Advan. Mater. Res.
Advances in Materials Research (U. S.)

Advan. Microbial Physiol.
Advances in Microbial Physiology (England)

Advan. Oto-Rhino-Laryngol.
Advances in Oto-Rhino-Laryngology (Switzerland)
Supersedes Bibliotheca Oto-Rhino-Laryngologica

AGARD Conf. Proc.
AGARD Conference Proceedings (France)

Agents Actions
Agents and Actions (Switzerland)

Agrochimica
Agrochimica (Italy)

AMDEL (Aust. Miner. Develop. Lab.) Bull.
AMDEL (Australian Mineral Development Laboratories) Bulletin (Australia)

Amer. Fam. Physician - GP
American Family Physician - GP (U. S.)
Supersedes GP, Journal of the American Academy of General Practice
Changed to American Family Physician

Amer. J. Int. Law
American Journal of International Law (U.S.)

Angew. Bot.
Angewandte Botanik (West Germany)

Ann. Chim. Appl.
Annali di Chimica Applicata (Italy)
Superseded by Annali di Chimica (Rome)

Ann. Gastroenterol. Hepatol.
Annales de Gastroenterologie et d'Hepatologie (France)

Ann. Limnol.
Annales de Limnologie (France)

Ann. Med. Interne
Annales de Medecine Interne (France)
Supersedes Bull. Mem. Soc. Med. Hop. Paris

Ann. Meteorol.
Annalen der Meteorologie (West Germany)

Ann. Soc. Geol. Belg.
Annales de la Societe Geologique de Belgique (Belgium)

Annu. Bull., Int. Dairy Fed.
Annual Bulletin, International Dairy Federation (Belgium)

Apidologie
Apidologie (France)
Supersedes Annales de l'Abeille

Arch. De Vecchi Anat. Patol. Med. Clin.
Archivio De Vecchi Anatomia Patological e la Medicina Clinic (Italy)

Arch. Fac. Med. Zaragoza
Archivos de la Facultad de Medicina de Zaragoza (Spain)

Arch. Tisiol. Mal. App. Resp.
Archivio di Tisiologia e delle Malattie dell'Apparato Respiratorio (Italy)

Argonne Rev.
Argonne Reviews (U. S.)
Supersedes Argonne National Laboratory Reviews

At. Energy Law Rep.
Atomic Energy Law Reports (U. S.)

Atherosclerosis
Atherosclerosis (Netherlands)
Supersedes Journal of Atherosclerosis Research

Aust. Chem. Eng.
Australian Chemical Engineering (Australia)

Aust. Chem. Process. Eng.
Australian Chemical Processing and Engineering (Australia)

Aust. Fish.
Australian Fisheries (Australia)

Aust. Food Mfr. Distrib.
Australian Food Manufacturer and Distributor (Australia)

Aust. J. Bot.
Australian Journal of Botany (Australia)

Aust. J. Soil Res.
Australian Journal of Soil Research (Australia)

Aust. J. Statist.
Australian Journal of Statistics (Australia)

Aust. N. Z. J. Med.
Australian and New Zealand Journal of Medicine (Australia)
Supersedes Australasian Annals of Medicine

Australas. J. Pharm., Sci. Suppl.
Australasian Journal of Pharmacy, Science Supplement (Australia)

Automot. Eng.
Automotive Engineering (U.S.)
Supersedes SAE (Soc. Automot. Eng.) J.

B

Beitr. Pathol.
Beitraege zur Pathologie (West Germany)
Supersedes Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie

Beitr. Radioastron.
Beitraege zur Radiostronomie (West Germany)

Betontech. Ber.
Betontechnische Berichte (West Germany)

Biochem. Soc. Symp.
Biochemical Society Symposia (England)

Biochimie
Biochimie (France)
Supersedes Bull. Soc. Chim. Biol.

Biol. Listy
Biologicke Listy (Czechoslovakia)

Biomed. Sci. Instrum.
Biomedical Sciences Instrumentation (U.S.)

Biom. Z.
Biometrische Zeitschrift (East Germany)

Bol. Estud. Med. Biol.
Boletin de Estudios Medicos y Biologicos (Mexico)

Boll. Soc. Ital. Fis.
Bollettino della Societa Italiana di Fisica (Italy)

Brit. J. Occup. Saf.
British Journal of Occupational Safety (England)

Brot Gebaeck
Brot und Gebaeck (West Germany)

Bul. Inst. Politeh. Brasov, Ser. B
Buletinul Institutului Politehnic din Brasov, Seria B. Economie Forestiera (Romania)

Bull. At. Sci.
Bulletin of the Atomic Scientists (U.S.)

Bull. Calcutta Sch. Trop. Med.
Bulletin of the Calcutta School of Tropical Medicine (India)

Bull. Inform. Bur. Nat. Metrol.
Bulletin d'Information du Bureau National de Metrologie (France)

Bull. Inst. Int. Froid
Bulletin de l'Institut International du Froid (France)

Bull., Int. Union Cancer
Bulletin, International Union Against Cancer (Switzerland)

Bull. Soc. Bot. Fr.
Bulletin de la Societe Botanique de France (France)

Bull. Tokyo Dent. Coll.
Bulletin of Tokyo Dental College (Japan)

Bul. Stiint. Univ. Craiova
Buletinul Stiintific al Universitatii Craiova (Romania)

Bussei Kenkyu
Bussei Kenkyu (Study of Property of Matter) (Japan)

Busseiron Kenkyu
Busseiron Kenkyu (Studies on Solid State Physics and Chemistry) (Japan)
Superseded by Bussei Kenkyu

Bygg
Bygg (Norway)

Byull., Abastumanskaya Astrofiz. Observ., Akad. Nauk Gruz. SSR
Byulleten, Abastumanskaya Astrofizicheskaya Observatoriya, Akademiya Nauk Gruzinskoi SSR (Georgian S.S.R.)

Byull. Gl. Bot. Sada
Byulleten Glavnogo Botanicheskogo Sada (U.S.S.R.)

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C

Cah. Med. (Paris)
Cahiers de Medecine (Paris) (France)
Supersedes Cah. Coll. Med.

Calif. Agr.
California Agriculture (U. S.)

Californium-252 Progr.
Californium-252 Progress (U. S.)

Can. Inst. Food Technol. J.
Canadian Institute of Food Technology Journal (Canada)

Carbohyd. Res.
Carbohydrate Research (Netherlands)

Cardiol. Prat.
Cardiologia Pratica (Italy)

Cesk. Pediat.
Ceskoslovenska Pediatrie (Czechoslovakia)

Cesk. Zdrav.
Ceskoslovenske Zdravotnictvi (Czechoslovakia)

Chem. Labor Betr.
Chemie fuer Labor und Betrieb (West Germany)

Chem. N. Z.
Chemistry in New Zealand (New Zealand)
Supersedes Journal of the New Zealand Institute of Chemistry

Chem. Scr.
Chemica Scripta (Sweden)
Supersedes Arkiv for Kemi

Chem. Technol.
Chemical Technology (U.S.)
Supersedes Ind. Eng. Chem.

Chest (Chicago)
Chest (Chicago) (U. S.)
Supersedes Diseases of the Chest

Chim. Anal.
Chimie Analitica
(Romania)

Chirurgie
Chirurgie (France)
Supersedes Memoires de l'Academie de Chirurgie

Chitaniumu Jirukoniumu
Chitaniumu Jirukoniumu (Titanium, Zirconium)
(Japan)

Chubu Nippon Seikei Geka Saigai Geka Gakkai Zasshi
Chubu Nippon Seikei Geka Saigai Geka Gakkai Zasshi
(The Central Japan Journal of Orthopaedic and
Traumatic Surgery) (Japan)

Chutanzo
Chutanzo (Casting and Forging) (Japan)

Ciel Terre
Ciel et Terre (Belgium)

Civil Def. Bull.
Civil Defence Bulletin (Australia)

Civil Eng. Trans., Inst. Eng., Aust.
Civil Engineering Transactions, Institution of Engineers,
The, Australia (Australia)

Combust. Sci. Technol.
Combustion Science and Technology (U. S.-England)

Commun. Dublin Inst. Advan. Stud., Ser. A
Communications of the Dublin Institute for Advanced Studies,
Series A (Ireland)

Comp. Biochem. Physiol., A
Comparative Biochemistry and Physiology, A. Comparative
Physiology (England)
Continues in part Comp. Biochem. Physiol.

Comp. Biochem. Physiol., B
Comparative Biochemistry and Physiology, B. Comparative
Biochemistry (England)
Continues in part Comp. Biochem. Physiol.

Composits
Composits (England)

Comput. Biol. Med.
Computers in Biology and Medicine (U.S.)

Constructeur
Constructeur, De (Absorbed Constructiematerialen)
(Netherlands)

Cost Eng.
Cost Engineering (U.S.)

Current (N. Y.)
Current (New York) (U. S.)

Curr. Notes Int. Aff.
Current Notes on International Affairs (Australia)

D

Daehan Hwahak Hwoejee
Daehan Hwahak Hwoejee (Journal of the Korean Chemical
Society) (South Korea)

Denshi Tsushin Gakkai Ronbunski, C
Denshi Tsushin Gakkai Ronbunshi, C (Japan)

Des. Eng. (London)
Design Engineering, Materials and Components (London)
(England)

Deut. Gewaesserk. Mitt.
Deutsche Gewaesserkundliche Mitteilungen (West Germany)

Develop. Appl. Spectrosc.
Developments in Applied Spectroscopy (U. S.)

Diastema
Diastema (South Africa)

Differential Equations (Engl. Transl.)
Differential Equations (English Translation of
Differentsial'nye Uravneniya) (U.S.)

E

East. Metals Rev.
Eastern Metals Review (India)

Eclogae Geol. Helv.
Eclogae Geologicae Helvetiae (Switzerland)

Economist (London)
Economist (London), The (England)

Ekol. Pol., Ser. B
Ekologia Polska, Seria B. Referaty, Dyskusje
Supersedes in Part Ekologia Polska

ELDO/ESRO Sci. Tech. Rev.
ELDO/ESRO Scientific and Technical Review (France)

Electro
Electro (Norway)
Supersedes Elektroteknisk Tidsskrfft

Electromedica
Electromedica (West Germany)

Electromyography
Electromyography (Belgium)

Elektronika
Elektronika (Formerly Przegiad Elektroniki) (Poland)

Elektrotehnika (Zagreb)
Elektrotehnika (Zagreb) (Yugoslavia)

Elelmez. Ipar
Elelmezesi Ipar (Hungary)

Energomashinostroenie
Energomashinostroenie (U.S.S.R.)

Erzmetall
Erzmetall (West Germany)
Supersedes Z. Erzbergbau Metallhuettenw.

Eur. J. Clin. Invest.
European Journal of Clinical Investigation (West Germany)
Supersedes Archiv fuer Klinische Medizin

Eur. Potato J.
European Potato Journal (Netherlands)

F

Fachber. Oberflaechentech.
Fachberichte fuer Oberflaechentechnik (West Germany)

Farbe Lack
Farbe und Lack (West Germany)

Farm. Obz.
Farmaceuticky Obzor (Czechoslovakia)

Faserforsch. Textiltech.
Faserforschung und Textiltechnik (East Germany)

Fields Quanta
Fields and Quanta (England)

Finska Laksresallsk. Handl.
Finska Lakaresallskapets Handlingar (Finland)

Fiziol. Biokhim. Kul't. Rast.
Fiziologiya i Biokhimiya Kul'turnykh Rastenii
(Ukrainian S. S. R.)

Fiz.-Khim. Mekh. Mater.
Fiziko-Khimicheskaya Mekhanika Materialov
(Ukrainian S.S.R.)
Issued in English translation as Soviet Materials Science

Fonderia Ital.
Fonderia Italiana (Italy)

Food Ind. J.
Food Industries Journal (India)

Forsch. Geb. Ingenieurw.
Forschung auf dem Gebiete des Ingenieurwesens
(West Germany)

Forsk. Framsteg
Forskning och Framsteg (Sweden)

Fortune
Fortune (U.S.)

Found. Phys.
Foundations of Physics (U.S.)

Frequenz
Frequenz (West Germany)

Fukushima Igaku Zasshi
Fukushima Igaku Zasshi (Fukushima Medical Journal) (Japan)

Funtai Kogaku
Funtai Kogaku (Powder Engineering) (Japan)

G

Ganka
Ganka (Ophthalmology) (Japan)

Gas- Wasserfach, Wasser - Abwasser
Gas- und Wasserfach, Wasser - Abwasser (West Germany)
Continues in part Gas- und Wasserfach, Das

Gaz, Woda Tech. Sanit.
Gaz, Woda i Technika Sanitarna (Poland)

Gen. Relativity Gravitation
General Relativity and Gravitation (England)

Geofiz. Sb.
Geofizicheskii Sbornik (Ukrainian S.S.R.)

Geol. Pruzkum
Geologicky Pruzkum (Czechoslovakia)

Geol. Zh. (Russ. Ed.)
Geologicheskii Zhurnal (Russian Edition) (Ukrainian
S.S.R.)

G. Psichiat. Neuropatol.
Giornale di Psichiatria e di Neuropatologia (Italy)

Gradbeni Vestn.
Gradbeni Vestnik (Yugoslavia)

Gynecol. Invest.
Gynecologic Investigation (Switzerland)
Supersedes Gynaecologia

H

Handelsblatt
Handelsblatt (West Germany)

Harefuah
Harefuah (Israel)

Heizung-Lueftung-Haustech.
Heizung-Lueftung-Haustechnik (West Germany)

Helgolaender Wiss. Meeresunters.
Helgolaender Wissenschaftliche Meeresuntersuchungen
(West Germany)

Hokkaido Kyoiku Daigsku Kiyo, Dai-2-Bu, C
Hokkaido Kyoiku Daigaku Kiyo, Dai-2-Bu, C, Katei, Taiiku-hen
(Journal of Hokkaido Univ. of Education, Section 2,
C, Domestic Science, Physical Education) (Japan)

Hoshasen Kagaku
Hoshasen Kagaku (Japan)

HSMHA Health Rep. (U.S.)
HSMHA (Health Services and Mental Health Administration)
Health Reports (U. S.)
Supersedes Public Health Reports (U. S.)

XUM

Hung. Sci. Instrum.
Hungarian Scientific Instruments (Hungary)

Husipar
Husipar (Hungary)

Hyomen
Hyomen (Surface) (Japan)

I

Iden
Iden (Heredity) (Japan)

Ig. Mod.
Igiene Moderna (Italy)

Indian J. Hort.
Indian Journal of Horticulture (India)

Indian J. Math.
Indian Journal of Mathematics (Indian)

Indian J. Pure Appl. Math.
Indian Journal of Pure and Applied Mathematics (India)

Indian J. Sci. Ind.
Indian Journal of Science and Industry (India)

Indian J. Sci. Ind., Sect. A
Indian Journal of Science and Industry, Section A. Agricultural Sciences (India)
Continues in part Indian Journal of Science and Industry

Indian Miner.
Indian Minerals (India)

Industriekurier
Industriekurier (West Germany)

Infec. Immunity
Infection and Immunity (U. S.)

Ingenieursblad
Ingenieursblad (Belgium)

Int. J. Environ. Stud.
International Journal of Environmental Studies, The (England)

Int. J. Magn.
International Journal of Magnetism (England - U. S.)

Ionos. Issled.
Ionosfernye Issledovaniya (U.S.S.R.)

Irrig. Power
Irrigation and Power (India)

Isotope Ind. Landwirt.
Isotope in Industrie und Landwirtschaft (Austria)

Izv. Akad. Nauk Arm. SSR, Geol. Geogr. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Geologischeskie i Geograficheskie Nauki (Armenian S.S.R.)
Superseded by Izv. Akad. Nauk Arm. SSR, Nauki Zemle

Izv. Akad. Nauk Kirg. SSR
Izvestiya Akademii Nauk Kirgizskoi SSR (Kirgiz S.S.R.)

Izv. Akad. Nauk SSSR, Mekh. Tverd. Tela
Izvestiya Akademii Nauk SSSR, Mekhanika Tverdogo Tela (U.S.S.R.)

Izv. Akad. Nauk SSSR, Ser. Geogr. Geofiz.
Izvestiya Akademii Nauk SSSR, Seriya Geograficheskaya i Geofizicheskaya (U.S.S.R.)

Izv. Akad. Nauk Turkm. SSR, Ser. Biol. Nauk
Izvestiya Akademiya Nauk Turkmenskoi SSR, Seriya Biologicheskikh Nauk (Turkmen S.S.R.)

J

J. Antibiot.
Journal of Antibiotics (Japan)
Supersedes Journal of Antibiotics, Series A

J. Appl. Chem. Biotechnol.
Journal of Applied Chemistry and Biotechnology (England)
Supersedes J. Appl. Chem. (London)

J. Aust. Entomol. Soc.
Journal of the Australian Entomological Society (Australia)

J. Brit. Astron. Ass.
Journal of the British Astronomical Association (England)

J. Clin. Pharmacol. New Drugs
Journal of Clinical Pharmacology and New Drugs (U.S.)
Supersedes J. Clin. Pharmacol. J. New Drugs

J. Cryst. Mol. Struct.
Journal of Crystal and Molecular Structure (England)

J. Forest.
Journal of Forestry (U.S.)

J. Helminthol.
Journal of Helminthology (England)

J. Inst. Nucl. Eng.
Journal of the Institution of Nuclear Engineers (England)
Supersedes Nuclear Energy

J. Lumin.
Journal of Luminescence (Netherlands)

J. Mammalogy
Journal of Mammalogy (U.S.)

J. Med. (Basel)
Journal of Medicine (Basel) (Switzerland)
Supersedes Medicina Experimentalis

J. Med. Microbiol.
Journal of Medical Microbiology (Scotland)

J. Membrane Biol.
Journal of Membrane Biology (U. S.)

J. Norw. Med. Ass.
Journal of the Norwegian Medical Association (Norway)

J. Oil Colour Chem. Ass.
Journal of the Oil and Colour Chemists' Association (England)

J. Phys., F (London)
Journal of Physics, F (London). Metal Physics (England)

J. Polym. Sci.
Journal of Polymer Science (U.S.)
Divided into Parts A through D

J. Polym. Sci., Part D
Journal of Polymer Science, Part D Macromolecular Reviews (U.S.)

J. Range Manage.
Journal of Range Management (U. S.)

J. Roy. Coll. Surg. Ireland
Journal of the Royal College of Surgeons in Ireland (Ireland)

J. Roy. Soc. West. Aust.
Journal of the Royal Society of Western Australia (Australia)

J. Therm. Anal.
Journal of Thermal Analysis (England)

J. Univ. Poona
Journal of the University of Poona (India)

K

Kagaku (Kyoto)
Kagaku (Kyoto) (Chemistry) (Japan)

Kagaku Gijutsushi - MOL
Kagaku Gijutsushi - MOL (Chemical Engineering - MOL) (Japan)

Kaijo Hoan Daigakko Kenkyu Hokoku, Dai-2-Bu
Kaijo Hoan Daigakko Kenkyu Hokoku, Dai-2-Bu (Journal of Maritime Safety Academy, Part 2) (Japan)

Kansai Ika Daigaku Zasshi
Kansai Ika Daigaku Zasshi (The Journal of the Kansai Medical School) (Japan)

Kaut. Gummi Kunstst.
Kautschuk und Gummi Kunststoffe (West Germany)

Kazan. Med. Zh.
Kazanskii Meditsinskii Zhurnal (U.S.S.R.)

Khim. Drev.
Khimiya Drevesiny (Latvian S.S.R.)

Khim. Tverd. Topl.
Khimiya Tverdogo Topliva (U.S.S.R.)

K'o Hsueh Hua Pao
K'o Hsueh Hua Pao (Science Pictorial) (China)

Konstr. Masch.-, App.- Geraetebau
Konstruktion im Maschinen-, Apparate- und Geraetebau (West Germany)

Konst. Svoistva Miner.
Konstitutsiya i Svoistva Mineralov (Ukrainian S.S.R.)

Korean J. Bot.
Korean Journal of Botany (South Korea)

Korean J. Microbiol.
Korean Journal of Microbiology (South Korea)

Krasnaya Zvezda
Krasnaya Zvezda (U.S.S.R.)

Kratk. Soobshch. Fiz.
Kratkie Soobshcheniya po Fizike (U.S.S.R.)

Kyoto Daigaku Kogaku Kenkyusho Iho
Kyoto Daigaku Kogaku Kenkyusho Iho (Bulletin of the Engineering Research Institute of Kyoto University (Japan)

Kyushu Ketsueki Kenkyu Dokokaishi
Kyushu Ketsueki Kenkyu Dokokaishi (Journal of Kyushu Hematological Society) (Japan)

L

Lantbrukshogsk. Ann.
Lantbrukshogskolans Annaler (Sweden)

Lebensm.-Wiss. Technol.
Lebensmittel-Wissenschaft und Technologie (Switzerland)

Lek. Zpr.
Lekarske Zpravy (Czechoslovakia)

Liet. TSR Aukst. Mokyklu Mokslo Darb., Chem. Chem. Technol.
Lietuvos TSR Aukstu ju Mokyklu Mokslo Darbai, Chemija ir Chemine Technologija (Lithuanian S.S.R.)

Linde Ber. Tech. Wiss.
Linde Berichte aus Technik und Wissenschaft (West Germany)

M

Maataloustieteellinen Aikak.
Maataloustieteellinen Aikakauskirja (Finland)

Mada
Mada (Israel)

Madras Agr. J.
Madras Agricultural Journal (India)

Manuscr. Math.
Manuscripta Mathematica (West Germany)

Maroc Med.
Maroc Medical (Morocco)

Mar. Pollut. Bull.
Marine Pollution Bulletin (England)

Maschinenmarkt
Maschinenmarkt (West Germany)

Maschinenschaden
Maschinenschaden (West Germany)

Mecan. Mater. Elec.
Mecanique Materiaux Electricite (France)
Supersedes Mecanique Electricite

Med. Probl.
Medicinski Problemi (Bulgaria)

Mekh. Avtomat. Upr.
Mekhanizatsiya i Avtomatizatsiya Upravleniya (Ukrainian S.S.R.)

Metaalbewerking
Metaalbewerking (Netherlands)

Metallgesellschaft
Metallgesellschaft (West Germany)

Metallges., Mitt. Arbeitsbereich
Metallgesellschaft, Mitteilungen aus dem Arbeitsbereich (West Germany)

Methods Comput. Phys.
Methods in Computational Physics (U. S.)

Methods Exp. Phys.
Methods of Experimental Physics (U.S.)

Microvasc. Res.
Microvascular Research (U. S. - England)

Minerva Oftalmol.
Minerva Oftalmologica (Italy)

Mod. Geol.
Modern Geology (England)

Munkavedelem
Munkavedelem (Hungary)

N

Nagoya Shiritsu Daigaku Igakkai Zasshi
Nagoya Shiritsu Daigaku Igakkai Zasshi (The Journal of the Nagoya City University Medical Association) (Japan)

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Nat. Develop.
National Development (Australia)

Nat. Saf. News
National Safety News (U. S.)

Nature (London) New Biol.
Nature (London) New Biology (England)

Nature (London) Phys. Sci.
Nature (London) Physical Science (England)

Natuurwetensch. Tijdschr. (Ghent)
Natuurwetenschappelijk Tijdschrift (Ghent) (Belgium)

Nauch. Tr. Vissh. Med. Inst., Sofia
Nauchni Trudove na Visshiya Meditsinski Institut, Sofia (Bulgaria)

Neuropharmacology
Neuropharmacology (England)
Supersedes International Journal of Neuropharmacology

New Sci. Sci. J.
New Scientist and Science Journal (England)
Formerly issued separately as New Scientist and Science Journal

Nippon Hoshasen Gijutsu Gakkai Zasshi
Nippon Hoshasen Gijutsu Gakkai Zasshi (Japanese Journal of Radiological Technology) (Japan)

Nippon Zosen Gakkaishi
Nippon Zosen Gakkaishi (Japan)

Nitrogen
Nitrogen (England)

Nogyo Doboku Gakkai-Shi
Nogyo Doboku Gakkai-Shi (Journal of the Agricultural Engineering Society, Japan) (Japan)

Norw. J. Zool.
Norwegian Journal of Zoology (Norway)
Continuation of Nytt Magasin for Zoologi

Nucl. Active
Nuclear Active (South Africa)

Nucl. Technol.
Nuclear Technology (U. S.)
Supersedes Nuclear Applications and Technology

Nutr. Metab.
Nutrition and Metabolism (Switzerland)
Supersedes Nutritio et Dieta

N. Y. Times Mag.
New York Times Magazine (U.S.)

O

Occup. Health Nurs.
Occupational Health Nursing (U. S.)

Oceans
Oceans (U. S.)

Ohio Rep.
Ohio Report (U.S.)

Organometal. Chem. Rev., Sect. A
Organometallic Chemistry Reviews, Section A. Subject Reviews (Netherlands)
Supersedes in part Organometallic Chemistry Reviews

Osp. Ital. Chir.
Ospedali d'Italia Chirurgia (Italy)

Osp. Magg.
Ospedale Maggiore (Italy)

Oyo Rikigaku Kenkyusho Shoho
Oyo Rikigaku Kenkyusho Shoho (Bulletin of the Research Inst. for Applied Machanics, Kyushu University) (Japan)

P

Period. Polytech., Mech. Eng.
Periodica Polytechnica, Mechanical Engineering (Hungary)
Supersedes Periodica Polytechnica, Engineering

Pharmacol. Res. Commun.
Pharmacological Research Communication (England)

Photogr. Appl. Sci., Technol. Med.
Photographic Applications in Science, Technology and Medicine (U.S.)
Supersedes Photogr. Appl. Sci. Technol.

Physiol. Chem. Phys.
Physiological Chemistry and Physics (U. S.)

Phys. Rep.
Physics Reports. A Review Section of Physics Letters (Section C) (Netherlands)

Phys. Status Solidi (b)
Physica Status Solidi (b). Basic Research (East Germany)
Suprsedes in part Physica Status Solidi

Phys. Unserer Zeit
Physik in Unserer Zeit (West Germany)

Plastverarbeiter
Plastverarbeiter (West Germany)

Ponpu Kogaku
Ponpu Kogaku (Pump Engineering) (Japan)

Postepy Astronaut.
Postepy Astronautyki (Poland)

Powder Met. Int.
Powder Metallurgy International (West Germany)

Prakt. Lek.
Prakticky Lekar (Czechoslovakia)

Probl. Arktiki Antarktiki
Problemy Arktiki i Antarktiki (U.S.S.R.)

Probl. Kosm. Phys.
Probleme der Kosmichen Physik (West Germany)

Probl. Metallioved. Fiz. Metal.
Problemy Metallovedeniya i Fiziki Metallov (U.S.S.R.)

Probl. Sov. Geol.
Problemy Sovetskoi Geologii (U.S.S.R.)

Proc. Aust. Soc. Anim. Prod.
Proceedings of the Australian Society of Animal Production (Australia)

Proc. Indian Nat. Sci. Acad., Part A
Proceedings of the Indian National Science Academy, Part A. Physical Sciences (Formerly Proceedings of the National Institute of Sciences of India, Part A) (India)

Proc. Indian Nat. Sci. Acad., Part B
Proceedings of the Indian National Science Academy, Part B. Biological Sciences (Formerly Proceedings of the National Institute of Sciences of India, Part B) (India)

Proc., Inst. Teknol. Bandung
Proceedings, Institut Teknologi Bandung (Indonesia)

Proc. Roy. Soc. Med., Suppl.
Proceedings of the Royal Society of Medicine, Supplement (England)

Progr. Nucl. Acid Res. Mol. Biol.
Progress in Nucleic Acid Research and Molecular Biology (Formerly Progress in Nucleic Acid Research) (U. S.)

Punjab Med. J.
Punjab Medical Journal (India)

Punjab Univ. J. Math.
Punjab University Journal of Mathematics, The (Pakistan)

Q

Que. Sci.
Quebec Science (Canada)
Supersedes Jeune Sci.

R

Reakts. Metody Issled. Org. Soedin.
Reaktsii i Metody Issledovaniya Organicheskikh Soedinenii (U.S.S.R.)

Recent Progr. Hormone Res.
Recent Progress in Hormone Research (U.S.)

Recherche (Paris)
Recherche, La (Paris) (France)
Supersedes Atomes (Paris)

Refract. Mater.
Refractory Materials (U.S.)

Rev. Agroquim. Tecnol. Aliment.
Revista de Agroquimica y Tecnologia de Alimentos (Spain)

Rev. Biol. Med. Nucl.
Revista de Biologia y Medicina Nuclear (Uruguay)

Rev. Brasil. Tecnol.
Revista Brasilerira de Tecnologia (Brazil)

Rev. Fr. Allergol.
Revue Francaise d'Allergologie (France)
Supersedes Revue Francaise d'Allergie

Rev. Inst. Pasteur Lyon
Revue de l'Institut Pasteur de Lyon (France)

Rev. Med. (Tirgu-Mures)
Revista Medicala (Tirgu-Mures) (Romania)

Rev. Mex. Fis., Supl. Reactor
Revista Mexicana de Fisica, Suplemento del Reactor (Mexico)

Rev. Venez. Sanid. Asistencia Soc.
Revista Venezolana de Sanidad y Asistencia Social (Venezuela)

Riv. Sper. Freniat. Med. Leg. Alienazioni Ment.
Rivista Sperimentale di Freniatria e Medicina Legale delle Alienazioni Mentali (Italy)

Rocz. Nauk Roln., Ser. B
Roczniki Nauk Rolniczych, Seria B. Zootechniczna (Poland)

S

Safety (London)
Safety (London) (England)

SAMPE J.
SAMPE (Society of Aerospace Material and Process Engineers) Journal (U.S.)

Sb. Nauch. Tr., Magnitogorsk. Gornomet. Inst.
Sbornik Nauchnykh Trudov, Magnitogorskii Gornometallurgicheskii Institut (U.S.S.R.)

Sb. Nauch. Tr., Tomsk. Inzh.-Stroit. Inst.
Sbornik Nauchnykh Trudov, Tomskii Inzhenerno-Stroitel'nyi Institut (U.S.S.R.)

Schweiz. Bauztg.
Schweizerische Bauzeitung (Switzerland)

Sci. Rep. Tokyo Kyoiku Daigaku, Sect. A
Science Reports of the Tokyo Kyoiku Daigaku, Section A (Japan)

Search
Search. Science, Technology and Society (Australia)
Supersedes Australian Journal of Science

Seibutsu Kagaku
Seibutsu Kagaku (Biological Science) (Japan)

Seisan Gijutsu
Seisan Gijutsu (Production Techique) (Japan)

Semento Kogyo
Semento Kogyo (Cement Industry) (Japan)

Semin. Nucl. Med.
Seminars in Nuclear Medicine (U.S.)

Seni Kobunshi Zairyo Kenkyusho Kenkyu Hokoku
Seni Kobunshi Zairyo Kenkyusho Kenkyu Hokoku (Japan)

Shigen Gijutsu Shikenjo Hokoku
Shigen Gijutsu Shikenjo Hokoku (Report of the Resources Research Institute) (Japan)

Shokuhin Eisei Kenkyu
Shokuhin Eisei Kenkyu (Food Hygiene Study) (Japan)

Showa Igakkai Zasshi
Showa Igakkai Zasshi (The Journal of the Showa Medical Association) (Japan)

Shoyakugaku Zasshi
Shoyakugaku Zasshi (Journal of Pharmacognosy) (Japan)

Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR
Soobshcheniya Byurakanskoi Observatorii, Akademiya Nauk Armyanskoi SSR (Armenian S.S.R.)

Sov. Zdravookhr. Kirg.
Sovetskoe Zdravookhranenie Kirgizii (Kirghiz S.S.R.)

Spec. Publ., Geol. Soc. Aust.
Special Publication, Geological Society of Australia (Australia)

SPIE Semin. Proc.
SPIE (Society of Photo-Optical Instrumentation Engineers) Seminar Proceedings (U.S.)

Springer Tracts Mod. Phys.
Springer Tracts in Modern Physics. Ergebnisse der Exakten Naturwissenschaften (West Germany)

Stahlbau
Stahlbau (West Germany)

Stomatologia (Bucharest)
Stomatologia (Bucharest) (Romania)

Strength Mater. (USSR) (Engl. Transl.)
Strength of Materials (USSR) (English Translation of Problemy Prochnosti) (U. S.)

Stud. Cercet. Met.
Studii si Cercetari de Metalurgie (Romania)

XUM

Suido Kyokai Zasshi
Suido Kyokai Zasshi (Journal of Water Works Association) (Japan)

Sumitomo Search
Sumitomo Search (Japan)

Symp. Zool. Soc. London
Symposia of the Zoological Society of London and The Malacological Society of London (England)

Synthesis
Synthesis (West Germany)

T

Tautsaimn. Derigie Augi
Tautsaimnieciba Derigie Augi (Latvian S.S.R.)

Tekniikka
Tekniikka (Finland)
Supersedes Teknillinen Aikakuslehti

Teplofiz. Teplotekh.
Teplofizika i Teplotekhnika (Ukrainian S.S.R.)

Termoproch. Mater. Konstr. Elem.
Termoprochnost Materialov i Konstruktivnykh Elementov (U.S.S.R.)

Tien Wen Hsueh Pao
Tien Wen Hsueh Pao (Journal of Astronomy) (China)

TNO Nieuws
TNO Nieuws (Netherlands)

Tohoku Nogyo Shikenjo Kenkyu Hokoku
Tohoku Nogyo Shikenjo Kenkyu Hokoku (Bulletin of the Tohoku National Agricultural Experiment Station) (Japan)

Tokyo Toritsu Eisei Kenkyusho Nempo
Tokyo Toritsu Eisei Kenkyusho Nempo (Annual Report of Tokyo Metropolitan Labs. for Medical Science) (Japan)

Tongmul Hakhoe Ji
Tongmul Hakhoe Ji (Korean Journal of Zoology) (South Korea)

Tool. Prod.
Tooling and Production (U. S.)

Trans. Amer. Foundrymen's Soc.
Transactions of the American Foundrymen's Society (U.S.)

Trans. J. Brit. Ceram. Soc.
Transactions and Journals of the British Ceramic Society (Incorporating British Ceramic Abstracts) (England)
Supersedes J. Brit. Ceram. Soc. and Trans. Brit. Ceram. Soc.

Trans. Soc. Advan. Electrochem. Sci. Technol.
Transactions of the Society for Advancement of Electrochemical Science and Technology (India)

Tr. Gidrometeorol. Nauch.-Issled. Tsent. SSSR
Trudy Gidrometeorologicheskogo Nauchno-Issledovatel'skogo Tsentra SSSR (U.S.S.R.)

Tr. Inst. Fiz. Zemli, Akad. Nauk SSSR
Trudy Instituta Fiziki Zemli, Akademiya Nauk SSSR (U.S.S.R.)

Tr. Inst. Met., Sverdlovsk
Trudy Instituta Metallurgii, Sverdlovsk (U.S.S.R.)

Tr. Mosk. Obshchest. Ispyt. Prir.
Trudy Moskovskogo Obshchestva Ispytatelei Prirody (U.S.S.R.)

Tr. 1 [Pervogo] Mosk. Med. Inst.
Trudy 1 [Pervogo] Moskovskogo Meditsinskogo Instituta (U.S.S.R.)

Tr. Tbilis. Gos. Univ.
Trudy Tbilisskogo Gosudarstvennogo Universiteta (Georgian S.S.R.)

U

Uch. Zap. Leningrad. Gos. Univ., Ser. Fiz. Nauk
Uchenye Zapiski Leningradskogo Gosudarstvennogo Universiteta, Seriya Fizicheskikh Nauk (U.S.S.R.)

Uch. Zap. Ural. Gos. Univ.
Uchenye Zapiski Ural'skogo Gosudarstvennogo Universiteta (U.S.S.R.)

Underwater J.
Underwater Journal and Information Bulletin (England)
Supersedes Underwater Science and Technology Journal

Urologe, Ausg. A
Urologe, Der, Ausgabe A (West Germany)
Supersedes in part Urologe, Der

V

Vestn. Beloruss. Gos. Univ., Ser. 2
Vestnik Belorusskogo Gosudarstvennogo Universiteta, Seriya 2. Biologiya, Khimiya, Geologiya, Geografiya (Belorussian S.S.R.)

Vestn. Khar'kov. Politekh. Inst.
Vestnik Khar'kovskogo Politekhnicheskogo Instituta (Ukrainian S.S.R.)

Vestn. Min. Zdrav.
Vestnik Ministerstva Zdravotnictvi (Czechoslovakia)

Vigyan Pragati
Vigyan Pragati (India)

Vod. Hospod., B
Vodni Hospodarstvi, B (Czechoslovakia)

Vop. Magmat. Metamorfiz.
Voprosy Magmatizma i Metamorfizma (U.S.S.R.)

W

Wasser, Luft Betr.
Wasser, Luft und Betrieb (West Germany)

Weather (London)
Weather (London) (England)

Weed Sci.
Weed Science (U.S.)

Werkstatt Betr.
Werkstatt und Betrieb (West Germany)

Wood Sci. Technol.
Wood Science and Technology (U.S.)

Wu Li Tung Pao
Wu Li Tung Pao (Physics Bulletin) (China)
Suspended publication

Y

Yuatsu Gijutsu
Yuatsu Gijutsu (Hydraulics and Pneumatics) (Japan)

Z

Zairyo Kagaku
Zairyo Kagaku (Journal of the Materials Science Society of Japan) (Japan)

Zesz. Nauk. Politech. Lodz., Chem. Spozyw.
Zeszyty Naukowe Politechniki Lodziej, Chemia Spozywcza (Poland)

Z. Rechtsmed.
Zeitschrift fuer Rechtsmedizin (West Germany)
Supersedes Deut. Z. Gesam. Gerichtl. Med.

Z. Tierphysiol. Tierernaehr. Futtermittelk.
Zeitschrift fuer Tierphysiologie Tierernaehrung und Futtermittelkunde (West Germany)

Z. Wasser- Abwasserforsch.
Zeitschrift fuer Wasser- und Abwasserforschung (West Germany)

Z. Wirt. Fertigung
Zeitschrift fuer Wirtschaftliche Fertigung (West Germany)

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